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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT ADDENDUM ZONE F VOLUME III OF V SECTIONS 10.5 TO 13 CNC CHARLESTON SC
3/31/1999
ENSAFE

ZONE F
RCRA FACILITY
INVESTIGATION REPORT - ADDENDUM
CHARLESTON NAVAL COMPLEX

VOLUME III of V
SECTIONS 10.5 to 13

CONTRACT N62467-89-D-0318
CTO-029

Prepared for:

Comprehensive Long-Term Environmental Action Navy (CLEAN)
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10.5 AOC 609, Service Station, Building 1346

AOC 609 is the former gasoline station, automotive repair and maintenance shop at Building 1346, which was built in 1962. The focus of the RFI is the waste oil UST at Building 1346. Materials released, stored or disposed of at the site included gasoline, diesel fuel, motor/lubricating oils, degreasing solvents, antifreeze and various automotive products.

This site contained USTs which contained gasoline and diesel fuel. Three of the original nine steel USTs were found to be leaking in 1991 and were removed. They were replaced with fiberglass tanks in 1992. Subsequently, six monitoring wells were installed by S&ME, Inc., to define the horizontal and vertical extent of groundwater contamination. The assessment report submitted to SCDHEC in February, 1993 resulted in the installation of two additional perimeter wells near the site. All site wells were resampled in November, 1994, with the results confirming previous findings. A source well near the site exhibited concentrations of benzene (36,100 μg/L), toluene (47,800 μg/L), ethylbenzene (3,620 μg/L), xylene (16,800 μg/L) and methyl tertiary butyl ether (62,200 μg/L). All perimeter wells were below detection limits for the same parameters. A free-product recovery system installed in 1995 is still in operation. This investigation activity was reported in the *Assessment Report Addendum Building No. 1346, Charleston Naval Base, Charleston, SC* (S&ME, March 29, 1995), prepared for the Navy Public Works Center Jacksonville, Charleston Zone.

The 560 gallon steel waste oil UST on the west side of the building being assessed in this RFI was removed in 1996. This tank received waste oil from floor drains in the maintenance garage, and was periodically emptied by suctioning to a waste oil truck. This removal was performed by the Supervisor of Shipbuilding, Conversion and Repair, USN, Portsmouth Detachment Environmental, Charleston, SC (SPORTENVDETCHASN). The *UST Assessment Report, UST 1346, Naval Base Charleston, Charleston, SC* (SPORTENVDETCHASN, September 3, 1996), prepared for the Department of the Navy, Southern Division, Naval Facilities Engineering Command, stated the UST was in good condition upon removal, having no holes or leaks, with its protective coating intact. However, a loose mechanical joint along the drain pipe leading to the tank was responsible for some leakage to soil about four feet from the tank. The north half of the removal excavation contained petroleum soils. Both tank and drain piping were removed. Ten soil samples were collected during this removal, along with one groundwater sample. Sample results for both soil and groundwater revealed the presence of inorganic, total recoverable petroleum hydrocarbon, and volatile constituents.

10.5.1 Site Geology and Hydrogeology

The soil boring and groundwater monitoring well locations associated with the AOC 609 RFI are shown in Figure 10.5-1. The general stratigraphy at AOC 609 was described based on two soil boring logs submitted by S&ME. Appendix A contains the construction logs for these two wells (SME007 and SME008; logs for the remaining S&ME wells were not available). No well borings were advanced during the RFI at AOC 609. The surface of AOC 609 is asphalt paved. The subsurface stratigraphy consists of approximately two feet of silty sand and overlying silty clay.

Figures 10.5-2 and 10.5-3 depict the shallow groundwater potentiometric surface and inferred flow direction during low and high tide, respectively. Flow is generally to the east-southeast during both tides. The geometric mean hydraulic conductivity measured in well SME004 was 0.089 ft/day. The horizontal gradient, based on Figure 10.5-2 is 3.5E-03. The horizontal flow velocity was calculated at 8.7E-04 ft/day in the shallow aquifer at AOC 609.

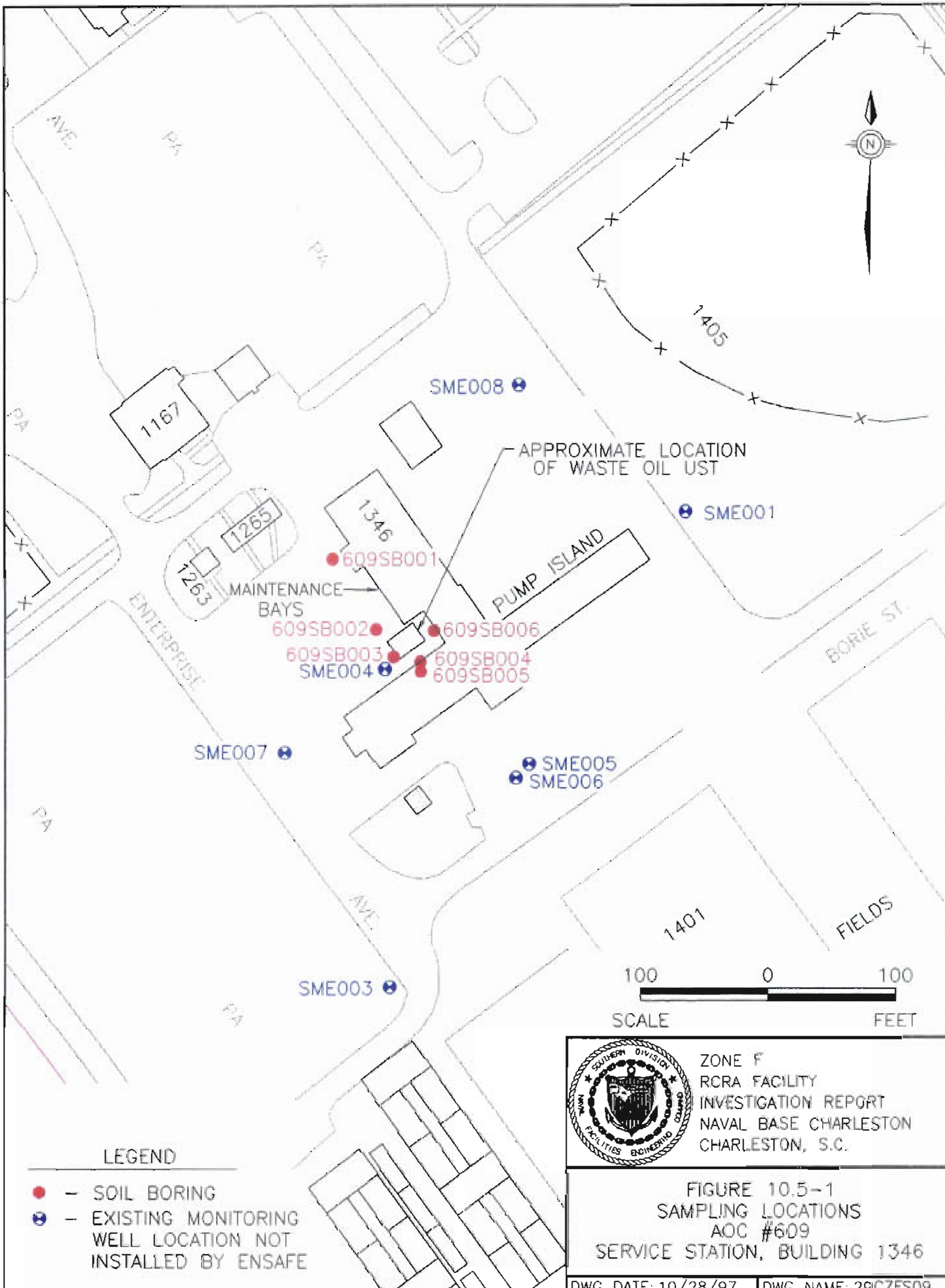

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FIGURE 10.5-1
SAMPLING LOCATIONS
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 10/28/97	DWG NAME: 29CZFS09

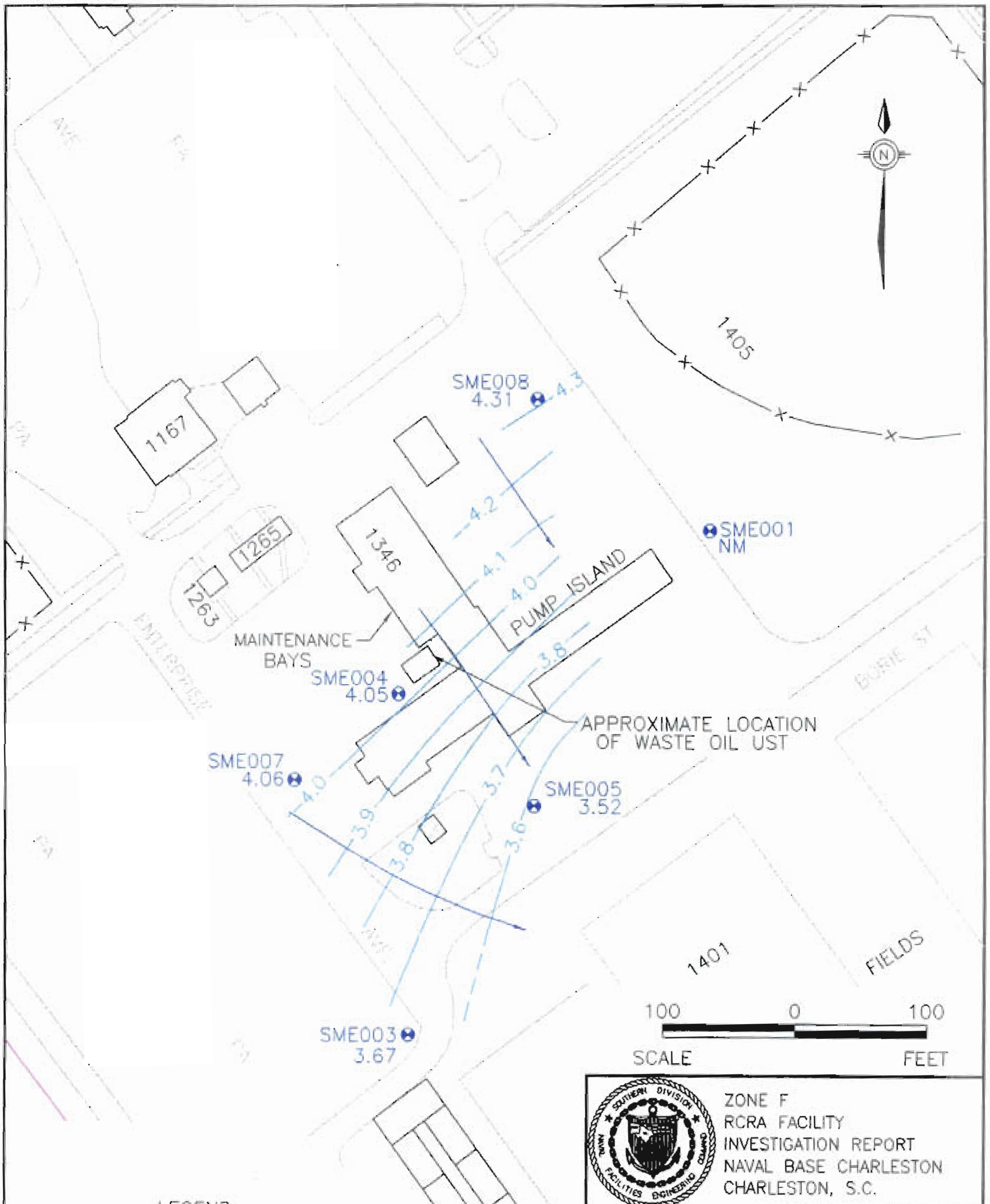

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FIGURE 10.5-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 10/29/97	DWG NAME: 2906SSLT

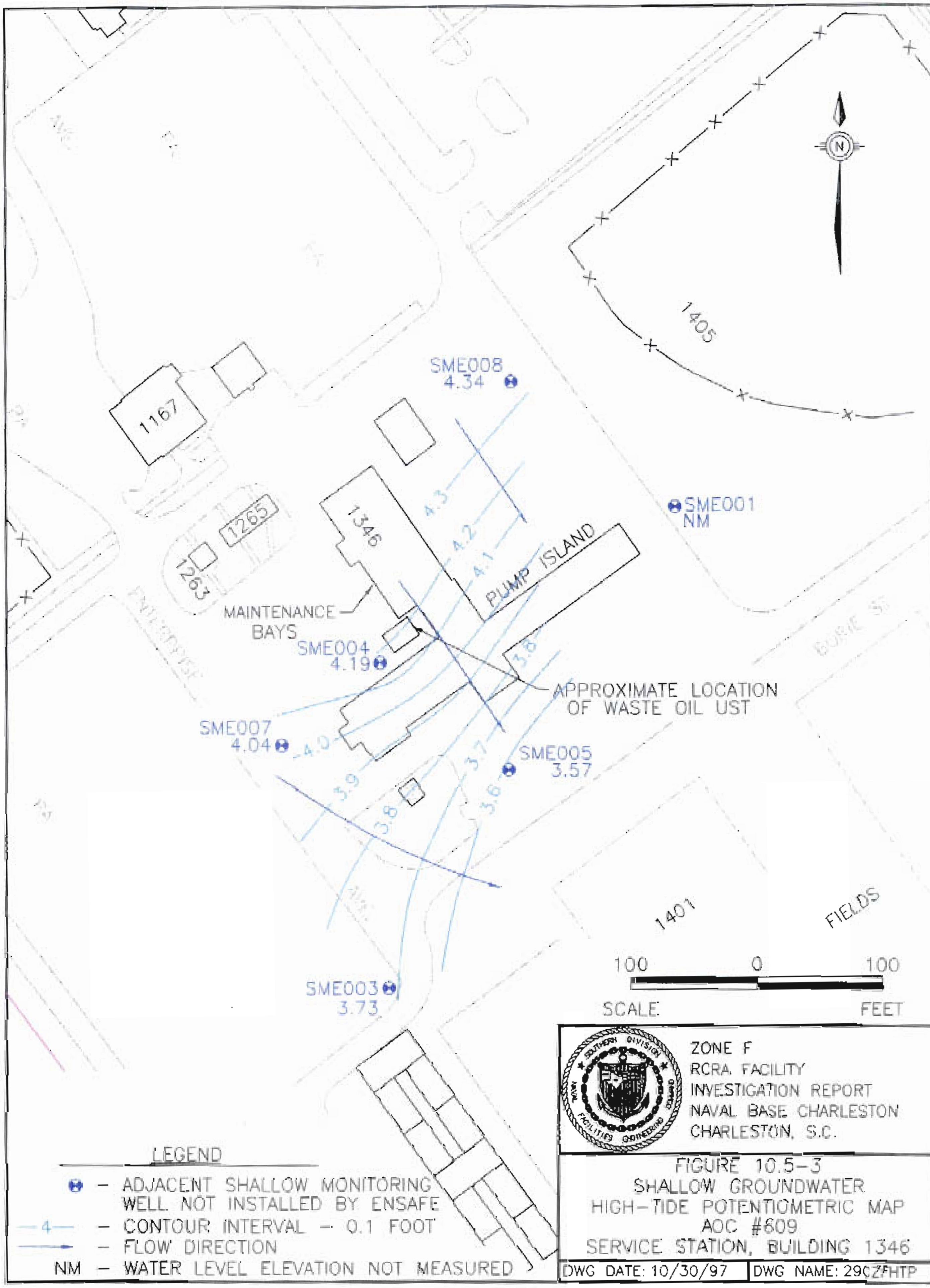

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FIGURE 10.5-3
SHALLOW GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 10/30/97 | DWG NAME: 29CZFHTP

10.5.2 Field Investigation Approach

The objectives of the field investigation at AOC 609 were to: (1) confirm the presence or absence of contamination related to the waste oil UST in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used for soil sampling; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix A included the construction diagrams for monitoring wells installed by S&ME. Please note, not all well construction diagrams were available.

10.5.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing four soil borings within the AOC 609 area to assess the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Six soil borings were advanced during the field investigation, as shown in Figure 10.5-1. The two additional soil sample locations were needed based on the results of the UST investigation (SPORTENVDETCHASN, September 3, 1996). Upper and lower interval samples were collected from four borings, while the two additional borings were sampled from the upper interval only. Where not collected, the lower interval sample was deleted due to obstructions in the borehole, or because of a shallow water table. In accordance with the approved final RFI work plan, soil samples were analyzed for metals, SVOAs, and VOAs at DQO Level III. Three upper interval duplicate soil samples were also collected for Appendix IX analyses at DQO Level IV. Table 10.5.1 summarizes the AOC 609 soil samples and analyses.

Table 10.5.1
AOC 609
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
609SB001	609SB00101	Upper	9/27/96	Notes 1/2	
	609CB00101*				*Duplicate sample
	609SB00102	Lower			
609SB002	609SB00201	Upper	9/27/96	Notes 1/2	
	609CB00201*				*Duplicate sample
	609SB00202	Lower			
609SB003	609SB00301	Upper	9/27/96	Notes 1/2	
	609CB00301*				*Duplicate sample
	609SB00302	Lower			
609SB004	609SB00401	Upper	9/30/96	Note 1	Lower interval not sampled because of obstruction
609SB005	609SB00501	Upper	9/30/96	Note 1	
	609SB00502	Lower			
609SB006	609SB00601	Upper	9/30/96	Note 1	Lower interval not sampled because of obstruction

Notes:
1 = SW-846 (metals, SVOAs, and VOAs)at DQO Level III
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample collected

10.5.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.5.2. Inorganic analytical results for soil are summarized in Table 10.5.3. Table 10.5.4 summarizes all analytes detected in soil at AOC 609. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organic Compounds in Soil

Six VOCs were detected in surface soil samples; all were below their respective RBCs. Two VOCs were detected in subsurface soil. All subsurface detections were also below their respective SSLs.

Table 10.5.2
AOC 609
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 6 Samples plus 3 Duplicate Samples/Lower Interval - 4 Samples) (µg/kg)						
1,1-Dichloroethene	Upper	1/6	4.0	4.0	1100	0
	Lower	0/4	ND	ND	60	0
2-Butanone (MEK)	Upper	2/6	7.0 - 8.0	7.5	4700000	0
	Lower	3/4	4.0 - 7.0	5.0	7900	0
Acetone	Upper	2/6	62 - 860	461	780000	0
	Lower	0/4	ND	ND	16000[a]	0
Acrolein	Upper	2/3	48 - 89	68.5	160000	0
	Lower	0/4	ND	ND	2940	0
Carbon disulfide	Upper	3/6	2 - 3	2.67	780000	0
	Lower	0/4	ND	ND	32000[a]	0
Trichloroethene	Upper	2/6	2 - 4	3	58000	0
	Lower	1/4	7	7	60	0
Semivolatile Organic Compounds (Upper Interval - 6 Samples plus 3 Duplicate Sample/Lower Interval - 4 Samples) (µg/kg)						
BEQs[1]	Upper	3/6	44.1 - 261.9	118	88.00	1
	Lower	0/0	NA	NA	NA	NA
2-Methylnaphthalene	Upper	1/6	55	55	310000	0
	Lower	0/4	ND	ND	126000	0
Benzo(a)anthracene	Upper	1/6	150	150	880	0
	Lower	0/4	ND	ND	2000[b]	0

Table 10.5.2
AOC 609
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (Upper Interval - 6 Samples plus 3 Duplicate Sample/Lower Interval - 4 Samples) (µg/kg)						
Benzo(a)pyrene	Upper	3/6	44 - 160	84.3	88	1
	Lower	1/4	81	81	8000	0
Benzo(b)fluoranthene	Upper	1/6	150	150	880	0
	Lower	0/4	ND	ND	5000[b]	0
Benzo(g,h,i)perylene	Upper	2/6	44 - 123.5	83.8	230000	0
	Lower	0/4	ND	ND	4.66E+08	0
Benzo(k)fluoranthene	Upper	1/6	135	135	8800	0
	Lower	0/4	ND	ND	49000[b]	0
Benzoic acid	Upper	1/6	52	52	31000000	0
	Lower	0/4	ND	ND	400000[b]	0
Butylbenzlphthalate	Upper	0/6	ND	ND	1600000	0
	Lower	1/4	56	56	930000[d]	0
Chrysene	Upper	2/6	51.5 - 180	116	88000	0
	Lower	0/4	ND	ND	160000[b]	0
Di-n-butylphthalate	Upper	1/6	40.0	40.0	780000	0
	Lower	2/4	40 - 42	41	2300000[d]	0
Dibenz(a,h)anthracene	Upper	1/6	60	60	88	0
	Lower	0/4	ND	ND	2000[b]	0
Fluoranthene	Upper	2/6	54 - 340	197	310000	0
	Lower	0/4	ND	ND	4300000[a]	0
Indeno(1,2,3-cd)pyrene	Upper	1/6	103.5	103.5	880	0
	Lower	0/0	ND	ND	14000[b]	0

Table 10.5.2
AOC 609
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (Upper Interval - 6 Samples plus 3 Duplicate Sample/Lower Interval - 4 Samples) (μg/kg)						
Phenanthrene	Upper	2/6	59.5 - 160	110	230000	0
	Lower	0/4	ND	ND	1380000	0
Pyrene	Upper	2/6	52.5 - 300	176	230000	0
	Lower	0/4	ND	ND	4200000[a]	0
bis(2-ethylhexyl)phthalate	Upper	3/6	43 - 84	64	46000	0
	Lower	3/4	47 - 58	52.7	3600000	0
Pesticides and PCBs (Upper Interval - 3 Duplicate Samples) (μg/kg)						
4,4-DDD	Upper	2/3	3.9 - 29.0	16.5	2700	0
	Lower	0/0	NA	NA	16000[b]	0
4,4'-DDE	Upper	3/3	4.4 - 84.0	34.5	1900	0
	Lower	0/0	NA	NA	54000[b]	0
Dioxins (Upper Interval - 3 Duplicate Sample) (ng/kg)						
Dioxin (2,3,7,8-TCDD TEQs[1])	Upper	3/3	0.0648 - 0.686	0.397	1000	0
	Lower	0/0	NA	NA	1900	NA

Notes:

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
a = Calculated values correspond to a noncancer hazard quotient of 1.
b = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c = SSL for pH of 6.8.
d = Soil saturation concentration (C_{sat}).
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
ND = Not detected
NA = Not applicable
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram

Table 10.5.3
AOC 609
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganic (Upper Interval - 6 Samples plus 3 Duplicate Samples/Lower Interval - 4 Samples) (mg/kg)						
Aluminum	Upper	6/6	4620 - 16650	9748	7800	5
	Lower	4/4	3890 - 9880	7100	1000000	0
Antimony	Upper	1/6	12.2	12.2	3.1	1
	Lower	0/4	ND	ND	5	0
Arsenic	Upper	6/6	2.9 - 113.8	25.7	0.43	6
	Lower	4/4	3.0 - 6.4	4.73	29[b]	0
Barium	Upper	6/6	16.4 - 88.85	42.48	550	0
	Lower	4/4	15.8 - 24.5	20.1	1600[b]	0
Beryllium	Upper	4/6	0.58 - 1.45	0.92	0.15	4
	Lower	0/4	ND	ND	63[b]	0
Cadmium	Upper	4/6	0.08 - 0.47	0.26	3.9	0
	Lower	1/4	0.12	0.12	8[b]	0
Calcium	Upper	6/6	673.5 - 33900	10989.75	NL	NA
	Lower	4/4	582 - 1480	875	NL	NA
Chromium	Upper	6/6	4.1 - 37.8	20.77	39	0
	Lower	4/4	4.4 - 20.1	11.4	38[b]	0
Cobalt	Upper	5/6	3.5 - 18.5	9.59	470	0
	Lower	1/4	2.0	2.0	2000	0
Copper	Upper	3/6	40.4 - 119.8	69.7	310	0
	Lower	0/4	ND	ND	920	0

Table 10.5.3
AOC 609
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganic (Upper Interval - 6 Samples plus 3 Duplicate Samples/Lower Interval - 4 Samples) (mg/kg)						
Iron	Upper	6/6	3120 - 22050	13345	2300	6
	Lower	4/4	3310 - 15100	9790	NL	NA
Lead	Upper	6/6	10.5 - 320	109.98	400[c]	0
	Lower	4/4	4.4 - 14.3	8.55	400[c]	0
Magnesium	Upper	6/6	303.5 - 2490	1468.08	NL	NA
	Lower	4/4	322 - 897	673	NL	NA
Manganese	Upper	6/6	65.8 - 392.5	203.97	180	3
	Lower	4/4	38.9 - 76.1	56.03	1100	0
Mercury	Upper	5/6	0.06 - 0.45	0.22	2.3	0
	Lower	2/4	0.05 - 0.06	0.055	2.0[b]	0
Nickel	Upper	6/6	2.4 - 28.4	12.76	160	0
	Lower	3/4	2.0 - 3.4	2.87	130[b]	0
Potassium	Upper	5/6	445 - 1390	817.4	NL	NA
	Lower	3/4	366 - 659	532.67	NL	NA
Tin	Upper	2/6	19.25 - 25.0	22.13	4700	0
	Lower	0/4	ND	ND	11000	0
Vanadium	Upper	6/6	6.15 - 44.0	27.19	55	0
	Lower	4/4	6.6 - 28.4	18.1	6000[a]	0
Zinc	Upper	5/6	120 - 715.5	291	2300	0
	Lower	1/4	34.8	34.8	12000[a,b]	0

Table 10.5.3
AOC 609
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 6 Samples plus 3 Duplicate Samples/Lower Interval - 4 Samples) (mg/kg)						
Cyanide	Upper	2/3	0.13 - 0.27	0.2	160	0
	Lower	0/0	NA	NA	40 amenable	0

Notes:

[a] = Calculated values correspond to a noncancer hazard quotient of 1
[b] = SSL for pH of 6.8
[c] = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA 1994a)
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
1,1-Dichloroethene	609SB001	4	1100	NA	ND	60	NA
2-Butanone (MEK)	609SB001	ND	4700000	NA	7.0	7900	NA
	609SB002	7			4.0		
	609SB003	ND			4.0		
	609SB004	8			NT		
Acetone	609SB001	860	780000	NA	ND	16000[a]	NA
	609SB002	62			ND		
Acrolein	609SB001	48	160000	NA	ND	2940	NA
	609SB003	89			ND		
Carbon disulfide	609SB001	3	780000	NA	ND	32000[b]	NA
	609SB002	2			ND		
	609SB003	2			ND		
Trichloroethene	609SB001	4	58000	NA	ND	60	NA
	609SB002	2			ND		
	609SB003	ND			7		
Semivolatile Organic Compounds (μg/kg)							
BEQ[1]	609SB001	261.9	88.0	NA	NA	NL	NA
	609SB002	44.1			NA		
	609SB003	49			NA		
2-Methylnaphthalene	609SB002	55	310000	NA	ND	126000	NA
Benzo(a)anthracene	609SB001	150	880.0	NA	ND	2000[b]	NA

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Benzo(a)pyrene	609SB001	160	88.0	NA	81	8000	NA
	609SB002	44			ND		
	609SB004	49			NT		
Benzo(b)fluoranthene	609SB001	150	880	NA	ND	5000[b]	NA
Benzo(g,h,i)perylene	609SB001	123.5	230000.0	NA	ND	4.66E+08	NA
	609SB006	44.0			NT		
Benzo(k)fluoranthene	609SB001	135	8800.0	NA	ND	49000[b]	NA
Benzoic acid	609SB002	52	31000000	NA	ND	400000[a,c]	NA
Butylbenzylphthalate	609SB005	ND	1600000	NA	56	930000[a]	NA
Chrysene	609SB001	180	88000.0	NA	ND	160000[b]	NA
	609SB002	51.5			ND		
Di-n-butylphthalate	609SB001	ND	780000	NA	40	2300000[a]	NA
	609SB002	40			ND		
	609SB003	ND			42		
Dibenz(a,h)anthracene	609SB001	60	88	NA	ND	2000[b]	NA
Fluoranthene	609SB001	340	310000.0	NA	ND	4300000[a]	NA
	609SB002	54			ND		
Indeno(1,2,3-cd)pyrene	609SB001	103.5	880	NA	ND	14000[b]	NA
Phenanthrene	609SB001	160	230000.0	NA	ND	1380000	NA
	609SB002	59.5			ND		

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds ($\mu g/kg$)							
Pyrene	609SB001	300	230000.0	NA	ND	4200000[a]	NA
	609SB002	52.5			ND		
bis(2-ethylhexyl)phthalate	609SB001	ND	46000	NA	58	3600000	NA
	609SB002	84			47		
	609SB003	ND			53		
	609SB005	43			ND		
	609SB006	65			NT		
Pesticides and PCBs ($\mu g/kg$)							
4,4'-DDD	609SB001	3.9	2700	NA	NA	16000[b]	NA
	609SB002	29.0					
4,4'-DDE	609SB001	15.0	1900.0	NA	NA	54000[b]	NA
	609SB002	84.0					
	609SB003	4.4					
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[t]	609SB001	0.6856	1000	NA	NA	1900	NA
	609SB002	0.4397			NA		
	609SB003	0.0648			NA		

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	609SB001	16650	7800.0	18500	3890	1000000	17100
	609SB002	11930			7180		
	609SB003	4620			7440		
	609SB004	8450			NT		
	609SB005	7940			9880		
	609SB006	8900			NT		
Antimony (Sb)	609SB002	12.2	3.1	0.79	ND	5	NL
Arsenic (As)	609SB001	14.5	0.43	19.9	3.0	29[c]	18.2
	609SB002	113.8			3.6		
	609SB003	2.9			5.9		
	609SB004	7.2			NT		
	609SB005	7.4			6.4		
	609SB006	8.6			NT		
Barium (Ba)	609SB001	43.85	550.0	61.5	15.8	1600[c]	51.8
	609SB002	88.85			24.5		
	609SB003	16.4			17.5		
	609SB004	31.5			NT		
	609SB005	23.0			22.7		
	609SB006	51.3			NT		
Beryllium (Be)	609SB001	0.94	0.15	1.05	ND	63[c]	1.20
	609SB002	1.45			ND		
	609SB004	0.58			NT		
	609SB006	0.72			NT		

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Cadmium (Cd)	**609SB001**	**0.08**	**3.9**	**0.26**	**0.12**	**8[c]**	**0.09**
	609SB002	**0.47**			**ND**		
	609SB004	**0.13**			**NT**		
	609SB006	**0.35**			**NT**		
Calcium (Ca)	609SB001	4085	NL	NL	764	NL	NL
	609SB002	2480			672		
	609SB003	673.4			582		
	609SB004	14700			NT		
	609SB005	10100			1480		
	609SB006	33900			NT		
Chromium (Cr)	**609SB001**	**27.6**	**39 VI** **7800 III**	**34.8**	**4.4**	**38[c] (total)**	**32.2**
	609SB002	**37.8**			**7.5**		
	609SB003	**4.1**			**13.6**		
	609SB004	**14.4**			**NT**		
	609SB005	**17.8**			**20.1**		
	609SB006	**22.9**			**NT**		
Cobalt (Co)	609SB001	18.5	470.0	15.1	ND	2000	6.85
	609SB002	13.45			ND		
	609SB004	3.8			NT		
	609SB005	3.5			2.0		
	609SB006	8.7			NT		
Copper (Cu)	**609SB002**	**119.8**	**310.0**	**48.2**	**ND**	**920**	**30.4**
	609SB004	**40.4**			**NT**		
	609SB006	**48.9**			**NT**		

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Cyanide (CN)	**609SB001**	**0.27**	**160.0**	**0.29**	**NA**	**40**	**0.24**
	609SB002	**0.13**			**NA**	**(Amenable)**	
Iron (Fe)	609SB001	21100	2300.0	NL	3310	NL	NL
	609SB002	22050			7150		
	609SB003	3120			13600		
	609SB004	11300			NT		
	609SB005	11500			15100		
	609SB006	11000			NT		
Lead(Pb)	**609SB001**	**61.05**	**400.0[d]**	**180**	**10.1**	**400[d]**	**51.7**
	609SB002	**161.50**			**4.4**		
	609SB003	**10.5**			**5.4**		
	609SB004	**54.4**			**NT**		
	609SB005	**52.4**			**14.3**		
	609SB006	**320.0**			**NT**		
Magnesium (Mg)	609SB001	2490	NL	NL	322	NL	NL
	609SB002	1665			588		
	609SB003	303.5			885		
	609SB004	1860			NT		
	609SB005	810			897		
	609SB006	1680			NT		

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Manganese (Mn)	609SB001	392.5	180.0	307	48.9	1100	469
	609SB002	305			38.9		
	609SB003	146.5			60.2		
	609SB004	181			NT		
	609SB005	65.8			76.1		
	609SB006	133			NT		
Mercury (Hg)	609SB001	0.45	2.3	0.62	0.03	2[c]	0.23
	609SB002	0.4			ND		
	609SB003	0.11			ND		
	609SB004	0.1			NT		
	609SB005	ND			0.06		
	609SB006	0.06			NT		
Nickel (Ni)	609SB001	10.65	160.0	12.6	2.0	130[c]	8.85
	609SB002	28.4			3.2		
	609SB003	2.4			ND		
	609SB004	6.4			NT		
	609SB005	6.1			3.4		
	609SB006	22.6			NT		
Potassium (K)	609SB001	1390	NL	NL	ND	NL	NL
	609SB002	1089			366		
	609SB003	ND			573		
	609SB004	556			NT		
	609SB005	445			659		
	609SB006	607			NT		

Table 10.5.4
AOC 609
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Tin (Sn)	**609SB002**	**19.25**	**4700**	**9.38**	**ND**	**11000**	**NL**
	609SB006	**25**			**NT**		
Vanadium (V)	609SB001	44	55.0	48.9	6.6	6000[a]	49.4
	609SB002	42.8			14.5		
	609SB003	6.15			22.9		
	609SB004	26.1			NT		
	609SB005	21.5			28.4		
	609SB006	22.6			NT		
Zinc (Zn)	**609SB001**	**120**	**2300.0**	**198**	**ND**	**12000[a,c]**	**84.2**
	609SB002	**715.5**			**ND**		
	609SB004	**189**			**NT**		
	609SB005	**201**			**34.8**		
	609SB006	**229**			**NT**		

Notes:

a	=	Calculated values correspond to a noncancer hazard quotient of 1.
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c	=	SSL for pH of 6.8.
d	=	A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
e	=	Soil saturation concentration (C_{sat}).
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
ND	=	Not detected
NT	=	Not taken
NL	=	Not listed
NA	=	Not applicable
μg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram
ng/kg	=	Nanograms per kilogram

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

Semivolatile Organic Compounds in Soil

Sixteen SVOCs were detected in soil samples at AOC 609. One benzo(a)pyrene detection exceeded a surface soil RBC. No subsurface SVOC concentration exceeded a SSL. Figure 10.5-4 presents total BEQ concentrations detected in surface soil.

Pesticides and PCBs in Soil

Two pesticides were detected in surficial soil. No PCBs were detected. No pesticide concentration exceeded a RBC or SSL in surface or subsurface soil samples, respectively.

Other Organic Compounds in Soil

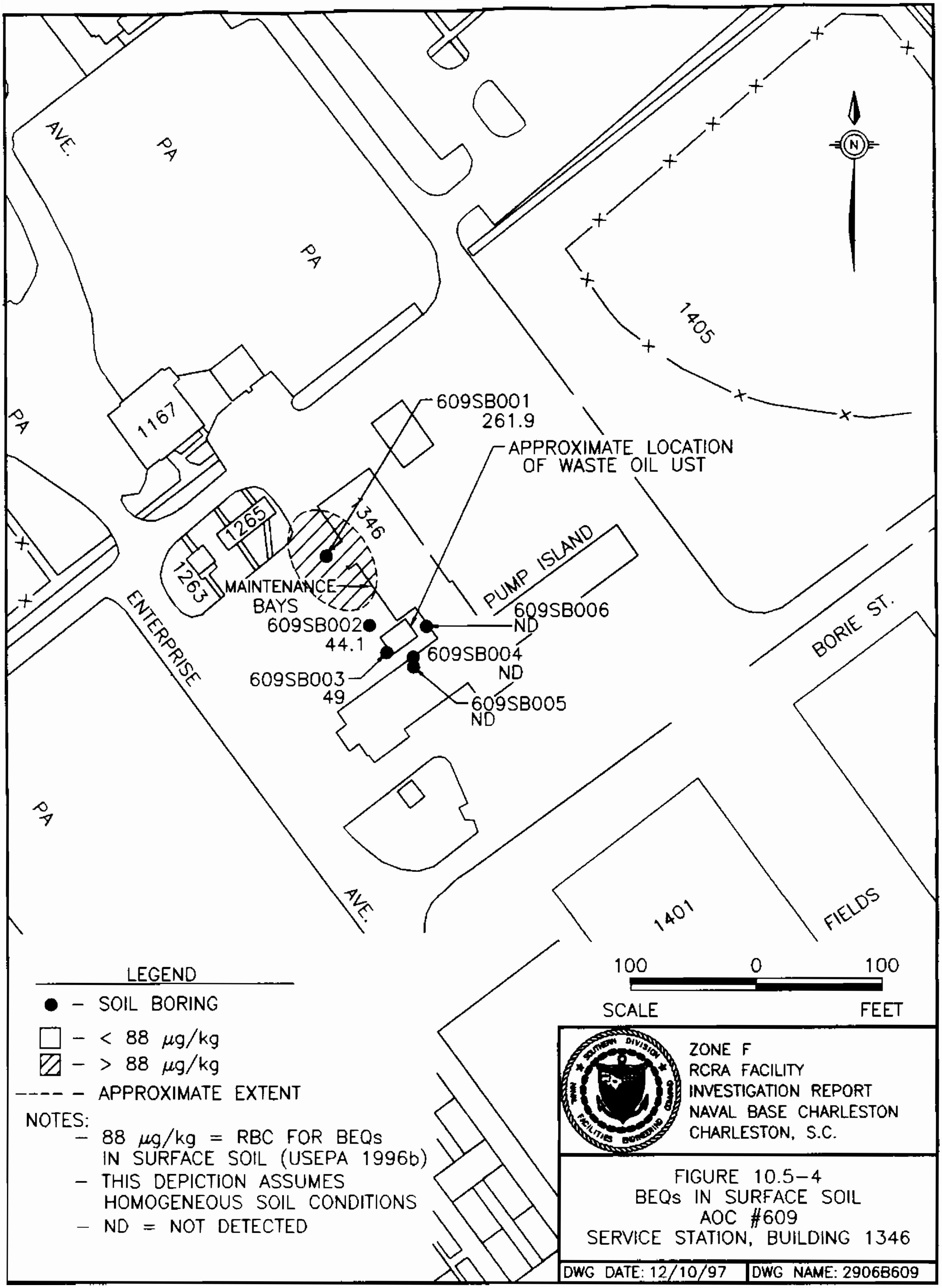
Concentrations of dioxin (2,3,7,8-TCDD TEQ) were detected in each of the three duplicate surface soil samples collected. These concentrations were below the RBC.

Inorganic Elements in Soil

Twenty metals plus cyanide were detected in soil samples collected at AOC 609. Antimony, arsenic, beryllium, and manganese concentrations exceeded both their respective RBCs and background concentrations for Zone F surface soil. Iron was detected exceeding its RBC; however, no background concentration is available for iron in surface soil. Figures 10.5-5 through 10.5-8 present the distribution of the inorganics that exceeded both RBCs and background in surface soil. No inorganics were detected in subsurface soil samples exceeding their SSLs.

10.5.4 Groundwater Sampling and Analysis

The approved final RFI work plan did not include a groundwater investigation in the sampling and analysis plan. However, seven existing wells (six shallow, one deep) within the AOC 609 area (Figure 10.5-1) were sampled during the field investigation to: (1) assess groundwater quality,



ZONE F
RCRA FACILITY INVESTIGATION REPORT
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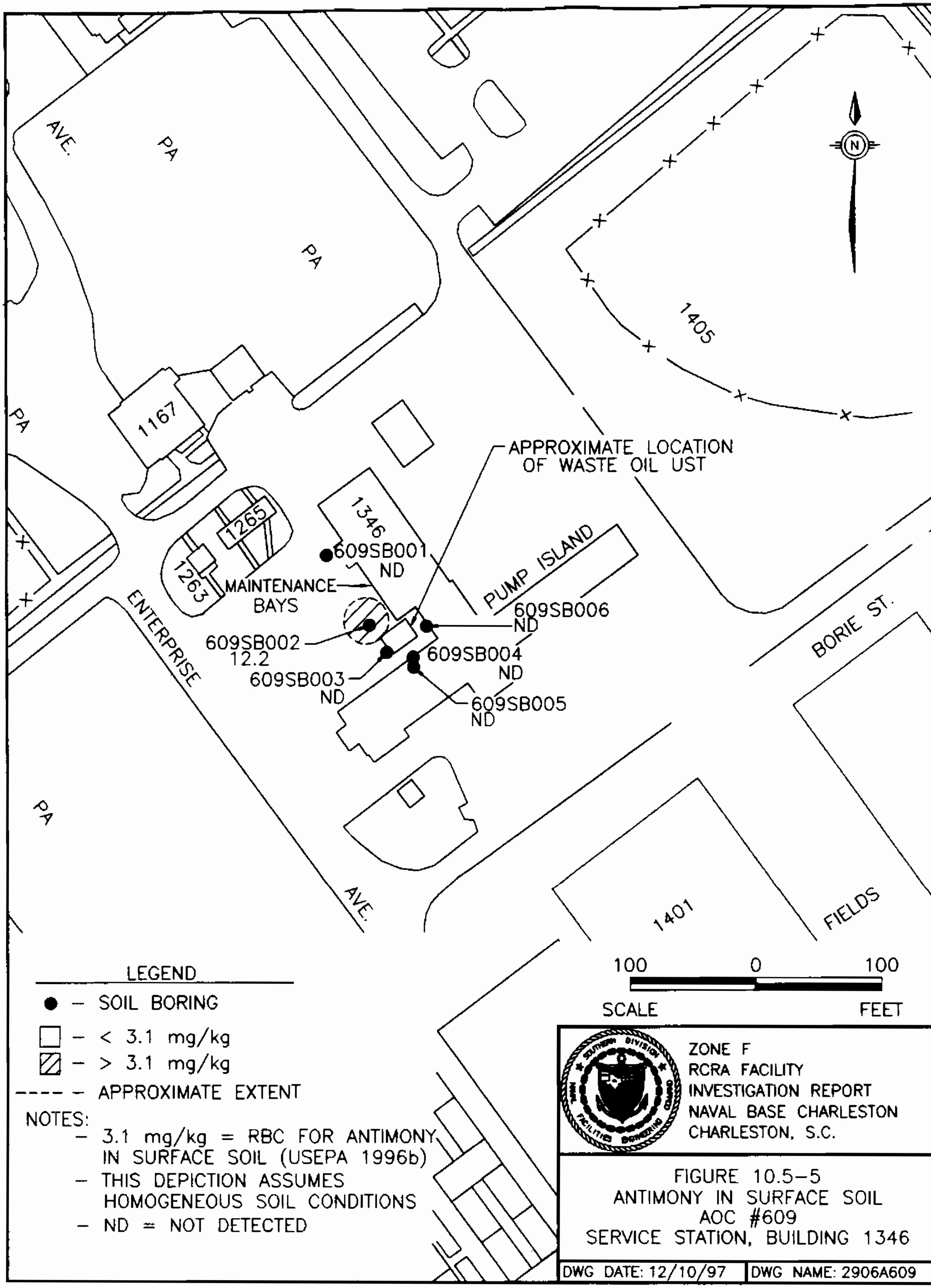
CHARLESTON, S.C.

FIGURE 10.5–4
BEQs IN SURFACE SOIL
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906B609



LEGEND

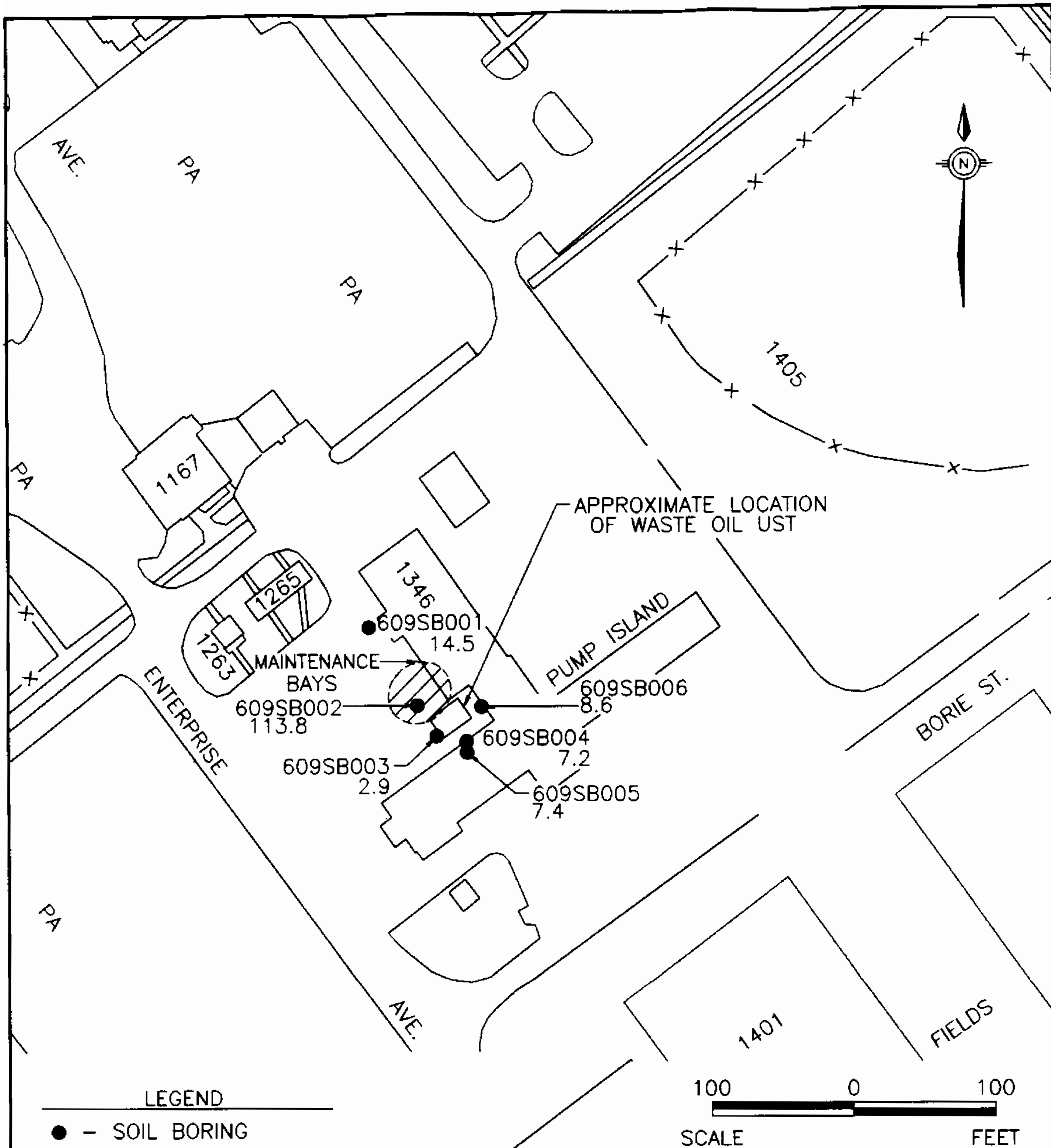
- ● – SOIL BORING
- ☐ – < 3.1 mg/kg
- ▨ – > 3.1 mg/kg
- - - - - – APPROXIMATE EXTENT

NOTES:
- 3.1 mg/kg = RBC FOR ANTIMONY IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5-5
ANTIMONY IN SURFACE SOIL
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906A609



LEGEND

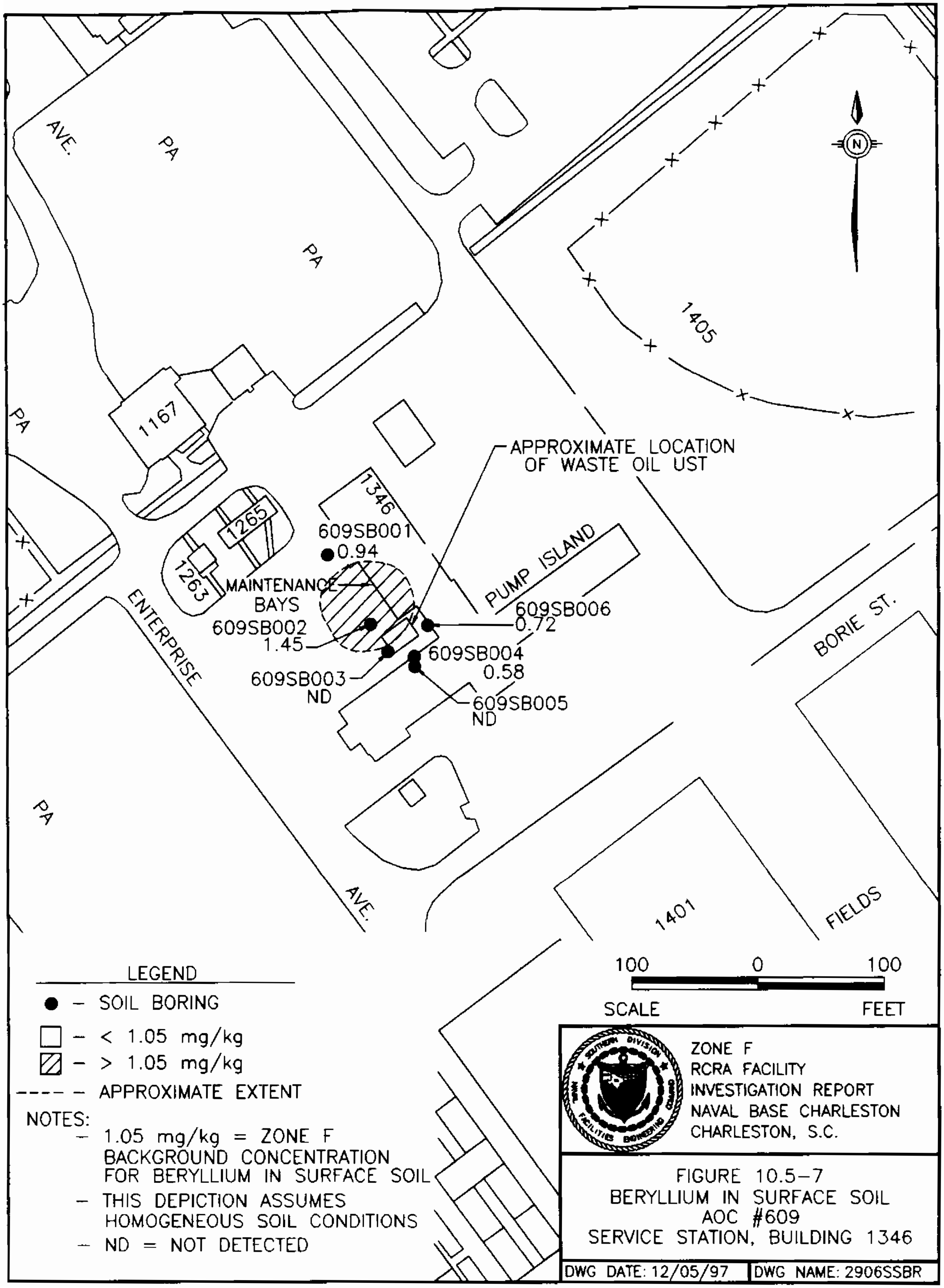
- ● – SOIL BORING
- □ – < 19.9 mg/kg
- ▨ – > 19.9 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 19.9 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN SURFACE SOIL
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE F
RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5-6
ARSENIC IN SURFACE SOIL
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/05/97 | DWG NAME: 2906AASR



ZONE F
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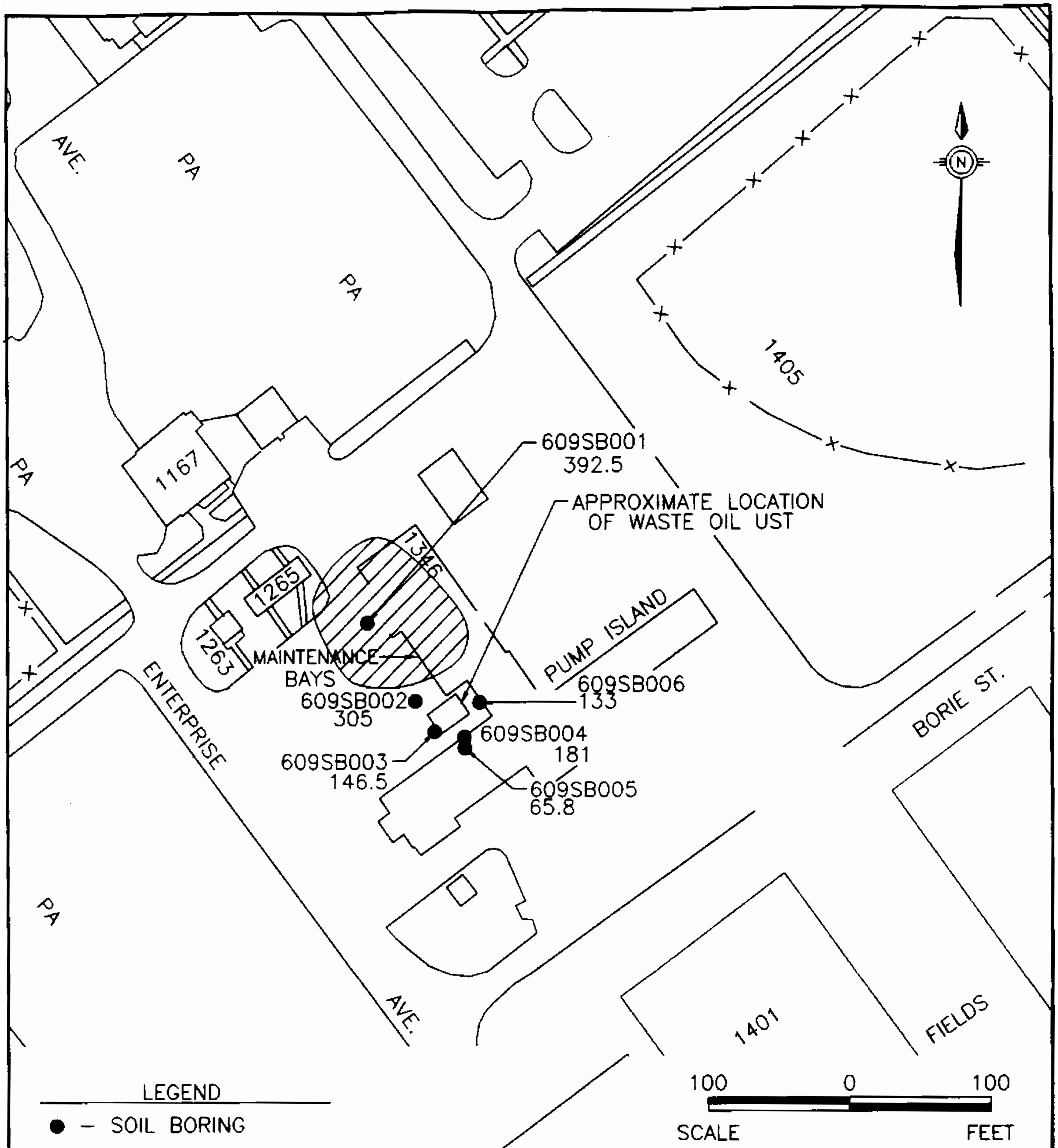
CHARLESTON, S.C.

FIGURE 10.5-7
BERYLLIUM IN SURFACE SOIL
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/05/97 | DWG NAME: 2906SSBR



LEGEND

- ● – SOIL BORING
- ☐ – < 307 mg/kg
- ▨ – > 307 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:

- 307 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR MANGANESE IN SURFACE SOIL
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE F
RCRA FACILITY
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5-8
MANGANESE IN SURFACE SOIL
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/05/97 | DWG NAME: 2906M609

and (2) identify contaminants which may be migrating from the site in the shallow aquifer. These wells had been previously installed during S&ME's 1995 investigation and removal of the UST system at Building 1346. Five of the shallow depth wells consisted of two-inch diameter schedule 40 PVC riser attached to 10-foot sections of 0.010-inch factory-slotted well screen, installed to a depth of approximately 13 ft bgs. One shallow depth well (SME005) was completed with a four-inch diameter riser. The deep well (SME006) was completed as a two-inch diameter well with a total depth of 26 ft bgs (SM&E, March 29, 1995). Groundwater samples were analyzed for metals, cyanide, pesticides/PCBs, SVOAs, and VOAs at DQO Level III. Table 10.5.5 summarizes groundwater samples and analyses at AOC 609.

Table 10.5.5
AOC 609 Groundwater Samples

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
SME001	Shallow	SME00101	11/21/96	Note 1	
SME003	Shallow	SME00301	11/13/96	Note 1	
SME004	Shallow	SME00401	11/21/96	Note 1	
SME005	Shallow	SME00501	11/13/96	Note 1	
SME006	Deep	SME00601	11/13/96	Note 1	
SME007	Shallow	SME00701*	11/13/96	Notes ½	*Duplicate sample
SME008	Shallow	SME00801	11/21/96	Note 1	

Notes:
1 = SW-846 (metals, pesticides/PCBs, SVOAs, and VOAs); cyanides Level III
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome Level IV
* = Duplicate sample collected
SME002 was not sampled because the well was damaged

10.5.4.1 Nature of Contamination in Groundwater

VOC, SVOCs, and inorganic analytes were detected in AOC 609 groundwater samples. Organic analytical results for groundwater are summarized in Table 10.5.6. Inorganic analytical results for groundwater are summarized in Table 10.5.7. Table 10.5.8 summarizes all analytes detected in groundwater at AOC 609.

Volatile Detected in Groundwater Samples

Five VOCs were detected in shallow groundwater. Benzene, chlorobenzene, ethylbenzene, toluene, and xylene, exceeded their respective tap water RBCs in the first quarter sampling. No VOCs were detected in the first quarter sample collected from the deep well. Figures 10.5-9 through 10.5-13 present the distribution of these VOCs in shallow groundwater at AOC 609.

Semivolatiles Detected in Groundwater Samples

Seven SVOCs were detected in shallow groundwater. The concentrations of 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and naphthalene, exceeded their respective tap water RBCs in first quarter samples. Figures 10.5-14 through 10.5-17 present the distribution of these SVOCs in shallow groundwater at AOC 609 during the first quarter sampling event.

Inorganic Elements in Groundwater Samples

Nineteen metals plus cyanide were detected in AOC 609 groundwater samples. Concentrations of aluminum and arsenic exceeded both their respective RBC and shallow groundwater background concentrations during first quarter sampling. Iron exceeded its respective RBC, but no background is available for this metal in Zone F groundwater. Figures 10.5-18 through 10.5-21 present the distribution of these metals in shallow groundwater at AOC 609 during the first quarter sampling event.

Table 10.5.6
AOC 609
Organic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding Reference
Volatile Organic Compounds (6 Shallow Samples plus 1 Duplicate Sample/1 Deep Sample) (μg/L)							
Benzene	Shallow	1/6	34000	34000	.36	5	1
	Deep	0/1	ND	ND			0
Chlorobenzene	Shallow	1/6	11	11	3.9	NL	1
	Deep	0/1	ND	ND			0
Ethylbenzene	Shallow	1/6	2400	2400	130	700	1
	Deep	0/1	ND	ND			0
Toluene	Shallow	1/6	56000	56000	75	1000	1
	Deep	0/1	ND	ND			0
Xylene	Shallow	1/6	15000	15000	1200	10000	1
	Deep	0/1	ND	ND			0
Semivolatile Organic Compounds (6 Shallow Samples plus 1 Duplicate Sample/1 Deep Sample) (μg/L)							
2,4-Dimethylphenol	Shallow	1/6	380	380	73	NL	1
	Deep	0/1	ND	ND			0
2-Methylnapththalene	Shallow	1/6	48	48	150	NL	0
	Deep	0/1	ND	ND			0
2-Methylphenol	Shallow	1/6	1000	1000	180	NL	1
	Deep	0/1	ND	ND			0
4-Methylphenol	Shallow	1/6	970	970	18	NL	1
	Deep	0/1	ND	ND			0

Table 10.5.6
AOC 609
Organic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (6 Shallow Samples plus 1 Duplicate Sample/1 Deep Sample) (μg/L)							
Benzoic Acid	Shallow	2/6	1 - 420	211	15000	NL	0
	Deep	0/1	ND	ND			0
Naphthalene	Shallow	1/6	540	540	150	NL	1
	Deep	0/1	ND	ND			0
Phenol	Shallow	1/6	810	810	2200	NL	0
	Deep	0/1	ND	ND			0

Notes:
NL = Not listed
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
MCL = Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
μg/L = Micrograms per liter
Data presented are from the initial sampling event only.

Table 10.5.7
AOC 609
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Inorganics (6 Shallow Samples plus 1 Duplicate Sample/1 Deep Sample) (μg/L)							
Aluminum	**Shallow**	**6/6**	**116 - 7745**	**2170**	**3700**	**50**	**2**
	Deep	**0/1**	**ND**	**ND**			**0**
Arsenic	Shallow	6/6	5.2 - 65.2	25.5	0.045	50	6
	Deep	1/1	38.7	38.7			1
Barium	**Shallow**	**6/6**	**5.9 - 61.9**	**32.1**	**260**	**2000**	**0**
	Deep	**1/1**	**64.6**	**64.6**			**0**
Calcium	Shallow	6/6	1720 - 69800	17900	NL	NL	NA
	Deep	1/1	246000	246000			NA
Chromium	**Shallow**	**2/6**	**12.65 - 14.3**	**13.48**	**18**	**100**	**0**
	Deep	**0/1**	**ND**	**ND**			**0**
Cobalt	Shallow	4/6	1.0 - 2.8	1.95	220	NL	0
	Deep	1/1	1.0	1.0			0
Copper	**Shallow**	**1/6**	**6.6**	**6.6**	**150**	**1000**	**0**
	Deep	**0/1**	**ND**	**ND**			**0**
Cyanide	Shallow	5/6	2.0 - 8.8	3.76	73	200	0
	Deep	0/1	ND	ND			0
Iron	**Shallow**	**6/6**	**1090 - 27300**	**10500**	**1100**	**300**	**5**
	Deep	**1/1**	**9020**	**9020**			**1**
Lead	Shallow	3/6	6.2 - 8.8	7.67	15	15	0
	Deep	0/1	ND	ND			0

Table 10.5.7
AOC 609
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Inorganics (6 Shallow Samples plus 1 Duplicate Sample/1 Deep Sample) (μg/L)							
Magnesium	Shallow	6/6	1570 - 136000	28400	NL	NL	NA
	Deep	1/1	133000	133000			NA
Manganese	Shallow	6/6	29.2 - 647	190	84	50	3
	Deep	1/1	1300	1300			1
Mercury	Shallow	3/6	0.17 - 0.22	0.19	11	2	0
	Deep	0/1	ND	ND			0
Nickel	Shallow	5/6	0.93 - 5.6	2.79	73	100	0
	Deep	1/1	9.3	9.3			0
Potassium	Shallow	5/6	5310 - 65300	21300	NL	NL	NA
	Deep	1/1	21300	21300			NA
Selenium	Shallow	2/6	4.1 - 13.5	8.8	18	50	0
	Deep	0/1	ND	ND			0
Silver	Shallow	1/6	2.7	2.7	18	100	0
	Deep	0/1	ND	ND			0
Sodium	Shallow	6/6	68000 - 1410000	458000	NL	NL	NA
	Deep	1/1	1220000	1220000			NA
Vanadium	Shallow	5/6	1.2 - 19.3	7.38	26	NL	0
	Deep	0/1	ND	ND			0

Table 10.5.7
AOC 609
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Inorganics (6 Shallow Samples plus 1 Duplicate Sample/1 Deep Sample) (μg/L)							
Zinc	Shallow	2/6	13.6 - 20.65	17.1	1100	5000	0
	Deep	1/1	6.2	6.2			0

Notes:
NL = Not listed
ND = Not detected
NA = Not applicable
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
μg/L = Micrograms per liter
MCL = Maximum contaminant level
SMCL = Secondary maximum contaminant level
Data presented are from initial sampling event only

Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Background
Volatile Organic Compounds (µg/L)							
1,2-Dichloroethane	SME005	ND	4.0	ND	0.12	5	NA
	SME006	ND	ND	3.0			NA
2-Butanone	SME005	ND	100	ND	190	NL	NA
Benzene	SME005	34000	18000	14000	.36	5	NA
Chlorobenzene	SME004	11	ND	ND	3.9	NL	NA
Chloroform	SME005	ND	8.0	ND	0.15	100	NA
Ethylbenzene	SME005	2400	1700	1000	130	700	NA
Toluene	SME005	56000	24000	17000	75	1000	NA
Xylene	SME005	15000	8600	4800	1200	10000	NA
Semivolatile Organic Compounds (µg/L)							
2,4-Dimethylphenol	SME005	380	120	110	73	NL	NA
2-Methylnaphthalene	SME005	48	110	64	150	NL	NA
2-Methylphenol	SME005	1000	220	290	180	NL	NA
4-Methylphenol	SME005	970	260	290	18	NL	NA
4-Nitrophenol	SME003	ND	ND	3.0	230	NL	NA

Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Background
Semivolatile Organic Compounds (μg/L)							
Benzoic Acid	SME001	1.0	ND	ND	15000	NL	NA
	SME004	ND	ND	4.0			
	SME005	420	ND	ND			
	SME006	ND	ND	4.0			NA
	SME007	ND	ND	4.0			
Naphthalene	SME005	540	240	330	150	NL	NA
Pentachlorophenol	SME005	ND	ND	2.0	0.56	NL	NA
Phenol	SME005	810	140	160	2200	NL	NA
Butylbenzylphthalate	SME008	ND	5	ND	730	NL	NL
Inorganics (μg/L)							
Aluminum (Al)	SME001	4450	394	ND	3700	50	224
	SME003	127	734	761			
	SME004	116	ND	ND			
	SME005	458	87.2	90.9			
	SME007	7745	105.1	6070			
	SME008	142	ND	ND			
Antimony (Sb)	SME001	ND	4.0	ND	1.5	6	NL
	SME003	ND	2.7	ND			

Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Background
Inorganics (µg/L)							
Arsenic (As)	**SME001**	**65.2**	**50.6**	**37.7**	**0.045**	**50**	**16.7**
	SME003	**6.5**	**8.0**	**3.6**			
	SME004	**15.9**	**20.4**	**16.6**			
	SME005	**41.6**	**48.7**	**58.5**			
	SME006	**38.7**	**33.6**	**52.2**			**16.2**
	SME007	**5.2**	**ND**	**3.1**			
	SME008	**18.4**	**21.6**	**31.2**			
Barium (Ba)	SME001	35.5	46.9	77	260	2000	94.3
	SME003	7.0	28.9	11.8			
	SME004	5.9	5.7	12.2			
	SME005	36.4	25.4	21.1			
	SME006	64.6	45.1	42.9			200
	SME007	61.9	12.1	25.6			
	SME008	45.9	42.5	36.9			
Beryllium (Be)	**SME001**	**ND**	**0.27**	**ND**	**0.016**	**4**	**0.66**
	SME003	**ND**	**1.0**	**ND**			
	SME006	**ND**	**0.31**	**ND**			**0.46**
	SME007	**ND**	**0.24**	**ND**			
Cadmium (Cd)	SME003	ND	0.47	ND	1.8	5	0.82
	SME005	ND	0.41	ND			
	SME008	ND	ND	0.72			

Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Background
Inorganics (µg/L)							
Calcium (Ca)	SME001	69800	71400	91200	NL	NL	NL
	SME003	4510	9640	6730			
	SME004	2300	1490	8040			
	SME005	1720	2210	2240			
	SME006	246000	154000	165000			NL
	SME007	18500	6530	7980			
	SME008	10500	10900	9680			
Chromium (Cr)	SME001	14.3	4.2	2.1	18	100	2.05
	SME003	ND	1.7	1.3			
	SME007	12.65	ND	12.15			
Cobalt (Co)	SME001	2.0	2.1	ND	220	NL	10.9
	SME003	ND	8.2	2.5			
	SME004	1.1	0.81	1.0			
	SME005	ND	1.8	1.5			
	SME006	1.0	9.0	6.7			67.0
	SME007	2.8	1.35	2.1			
	SME008	1.9	2.1	1.9			
Copper (Cu)	SME001	6.6	3.5	ND	150	1000	NL
	SME003	ND	4.1	ND			
	SME006	ND	ND	2.4			NL
	SME007	ND	ND	3.0			
Cyanide (Cn)	SME003	2.9	NT	NT	73	200	3.3
	SME004	8.8	NT	NT			
	SME005	2.3	NT	NT			
	SME007	2.0	NT	NT			
	SME008	2.8	NT				

Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Background
Inorganics (μg/L)							
Iron (Fe)	**SME001**	**27300**	**7340**	**5270**	**1100**	**300**	**NL**
	SME003	1090	**6280**	**1330**			
	SME004	**1500**	**2780**	**2000**			
	SME005	**7310**	**19800**	**17000**			
	SME006	**9020**	**6080**	**7030**			**NL**
	SME007	**8095**	**408**	**4870**			
	SME008	**18000**	**16100**	**16000**			
Lead (Pb)	SME001	6.2	ND	ND	15	15	NL
	SME003	ND	18.7	ND			
	SME005	8.8	5.4	ND			
	SME007	6.35	ND	ND			
Magnesium (Mg)	**SME001**	**136000**	**58900**	**47500**	**NL**	**NL**	**NL**
	SME003	**3410**	**5140**	**4320**			
	SME004	**1570**	**1530**	**2980**			
	SME005	**1990**	**2960**	**2790**			
	SME006	**133000**	**87500**	**86000**			**NL**
	SME007	**7320**	**2630**	**3290**			
	SME008	**20300**	**24500**	**20500**			
Manganese (Mn)	SME001	647	823	**3310**	84	50	2010
	SME003	45.6	113	66.1			
	SME004	29.2	36.4	33.5			
	SME005	38.0	64.3	58.4			
	SME006	**1300**	**1740**	1150			1260
	SME007	186.5	61.2	78.95			
	SME008	195	139	121			

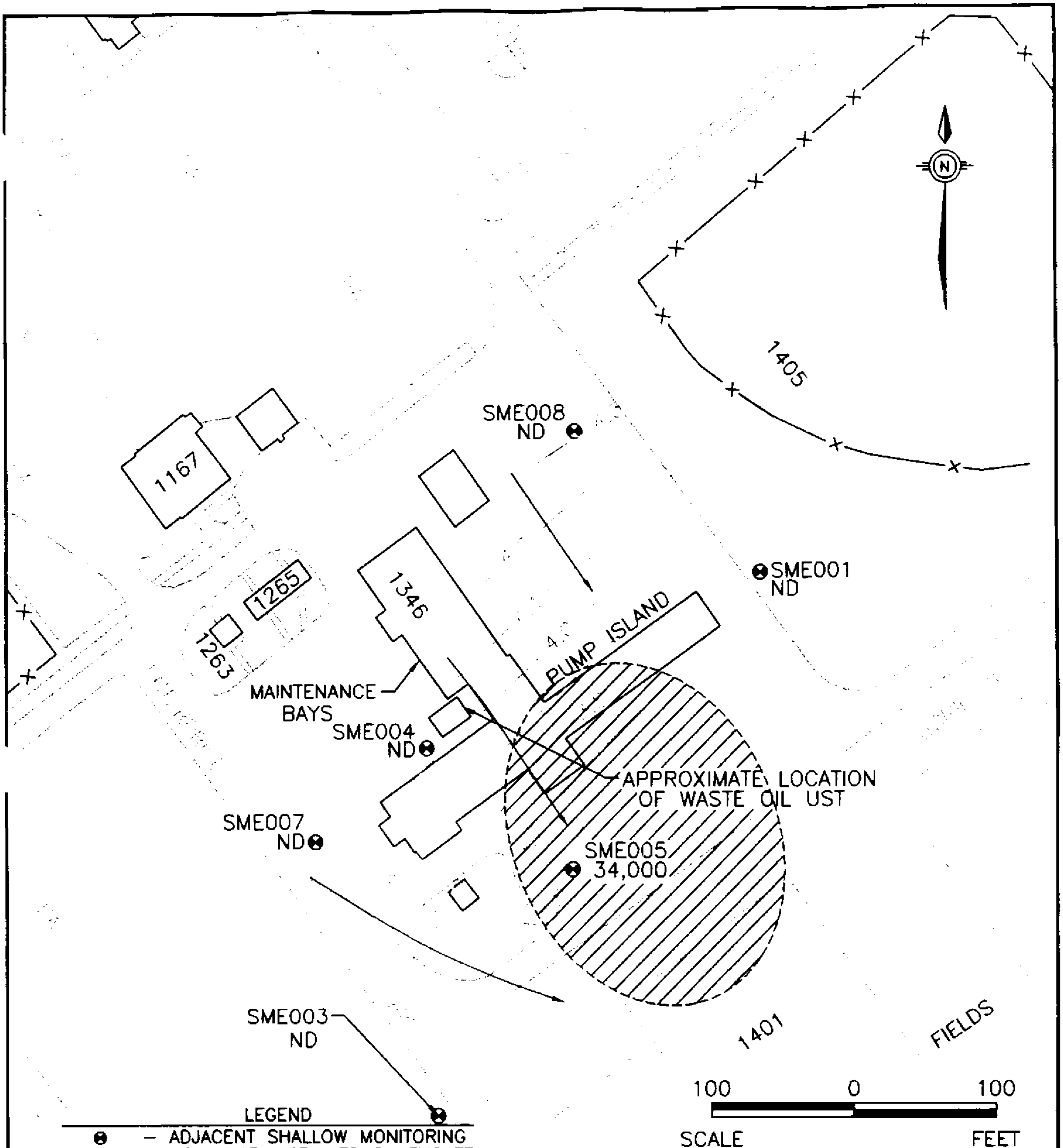
Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Background
Inorganics (µg/L)							
Mercury (Hg)	SME001	ND	ND	0.61	11	2	NL
	SME003	0.22	ND	ND			
	SME005	0.17	0.12	ND			
	SME007	0.17	ND	ND			
Nickel (Ni)	SME001	5.6	3.1	ND	73	100	5.55
	SME003	1.4	3.5	ND			
	SME004	2.1	1.9	ND			
	SME006	9.3	16.2	18.7			61.1
	SME007	3.9	0.775	ND			
	SME008	0.93	ND	ND			
Potassium (K)	SME001	65300	42200	28000	NL	NL	NL
	SME003	5310	4330	5800			
	SME004	7310	6560	9220			
	SME005	ND	1430	1730			
	SME006	21300	14900	10900			NL
	SME007	6135	4320	4555			
	SME008	22200	24300	20000			
Selenium (Se)	SME003	4.1	ND	ND	18	50	NL
	SME005	13.5	10.8	8.2			
	SME007	ND	4.4	ND			
Silver (Ag)	SME001	ND	1.8	ND	18	100	NL
	SME007	2.7	ND	ND			

Table 10.5.8
AOC 609
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Background
Inorganics (μg/L)							
Sodium (Na)	SME001	1410000	585000	234000	NL	NL	NL
	SME003	314000	308000	251000			
	SME004	246000	246000	246000			
	SME005	68000	83000	78000			
	SME006	1220000	1060000	1070000			NL
	SME007	241500	115000	114000			
	SME008	470000	545000	510000			
Thallium (Tl)	SME006	ND	9.3	ND	0.29	2	8.18
Vanadium (V)	SME001	19.3	8.9	9.3	26	NL	1.58
	SME003	2.4	2.1	2.2			
	SME004	1.2	ND	1.3			
	SME005	1.4	ND	1.7			
	SME007	12.6	1.25	10.3			
Zinc (Zn)	SME003	13.6	ND	22.5	1100	5000	NL
	SME006	6.2	ND	ND			NL
	SME007	20.65	86.3	ND			

Notes:
NL = Not listed
NA = Not applicable
MCL = Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
μg/L = Micrograms per liter
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
Bolded concentrations exceed both the RBC and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background values for groundwater are based on two sampling rounds in two wells at each depth.
Well SME006 is complete in the lower portion of the surficial aquifer.



LEGEND

- – ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- – CONTOUR INTERVAL – 0.1 FOOT
- – FLOW DIRECTION
- – < 0.36 $\mu g/L$
- – > 0.36 $\mu g/L$
- – APPROXIMATE EXTENT

NOTES:
- 0.36 $\mu g/L$ = TAP RBC FOR BENZENE (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN $\mu g/L$

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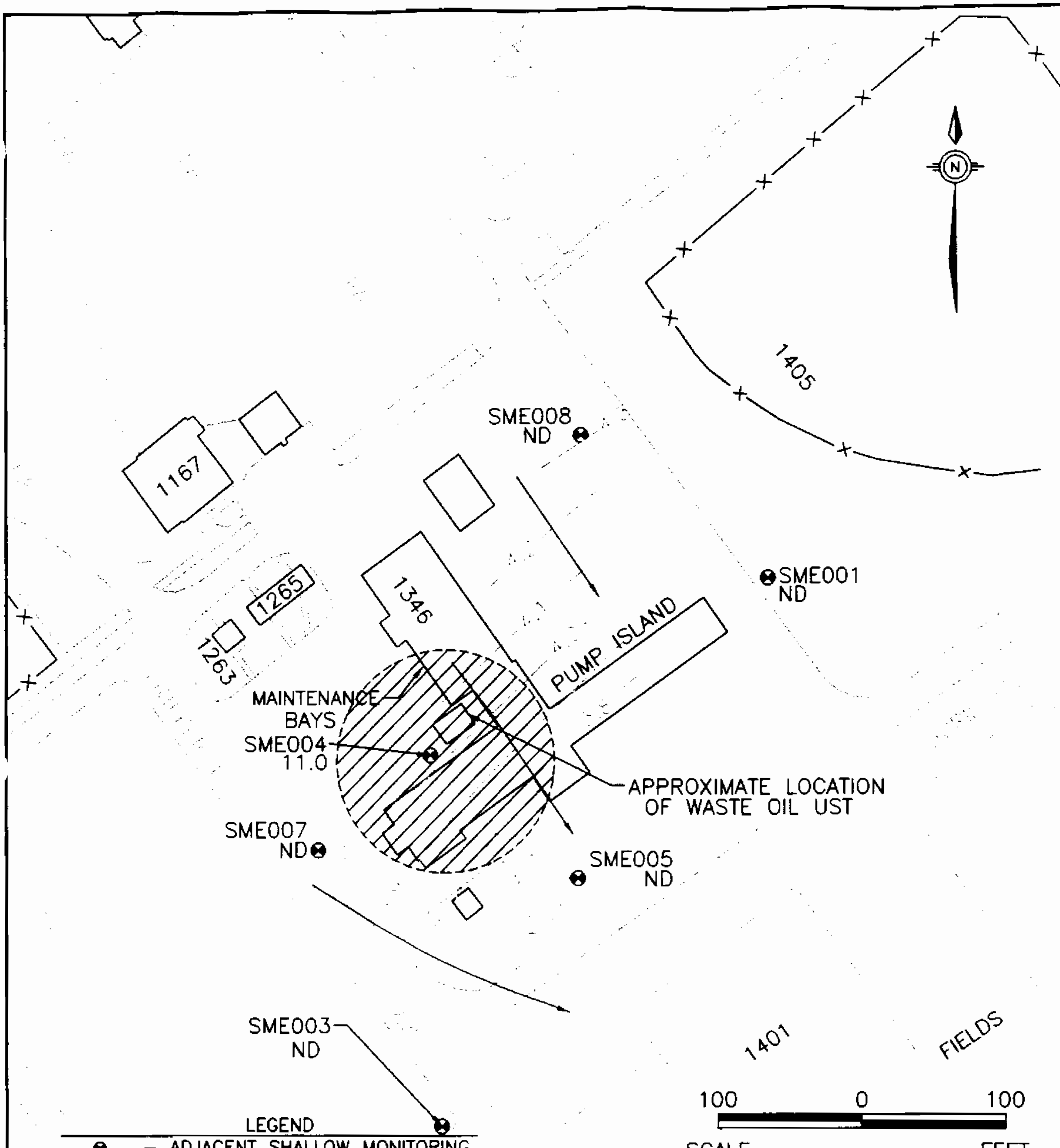
FIGURE 10.5–9
BENZENE IN SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906AOCB



LEGEND

- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 0.1 FOOT
- FLOW DIRECTION
- < 3.9 μg/L
- > 3.9 μg/L
- APPROXIMATE EXTENT

NOTES:
- 3.9 μg/L = TAP RBC FOR CHLOROBENZENE (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- RESULTS IN μg/L

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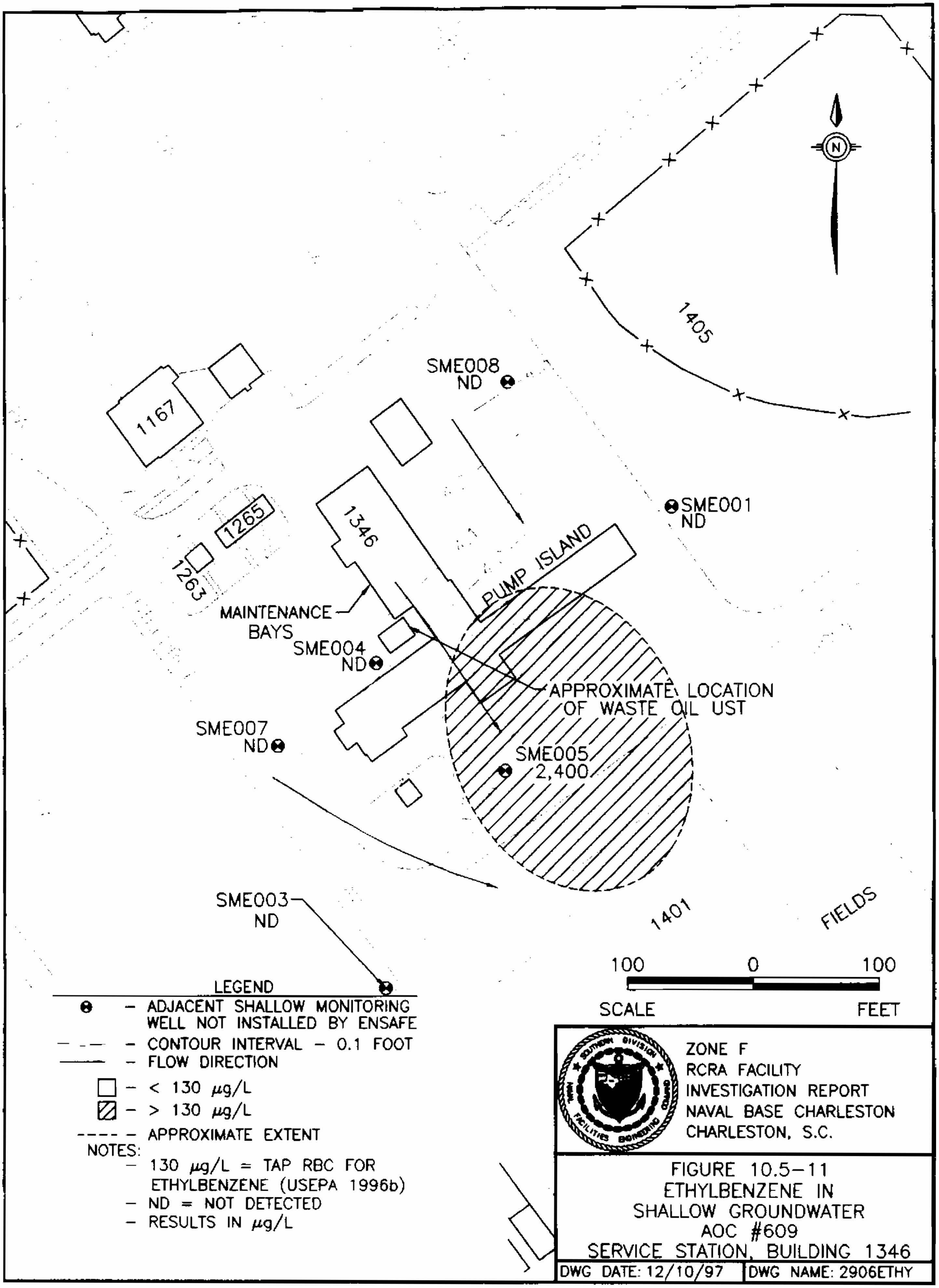
FIGURE 10.5–10
CHLOROBENZENE IN
SHALLOW GROUNDWATER
AOC #609
SERVICE SATION, BUILDING 1346

DWG DATE: 12/11/97	DWG NAME: 2906CHAC


1405
SME008
ND
SME001
ND
1167
1265
1263
1346
PUMP ISLAND
MAINTENANCE
BAYS
SME004
ND
APPROXIMATE LOCATION
OF WASTE OIL UST
SME007
ND
SME005
2,400
SME003
ND
1401
FIELDS
100 0 100
SCALE FEET
LEGEND
– ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– CONTOUR INTERVAL – 0.1 FOOT
– FLOW DIRECTION
– < 130 μg/L
– > 130 μg/L
– APPROXIMATE EXTENT
NOTES:
– 130 μg/L = TAP RBC FOR ETHYLBENZENE (USEPA 1996b)
– ND = NOT DETECTED
– RESULTS IN μg/L
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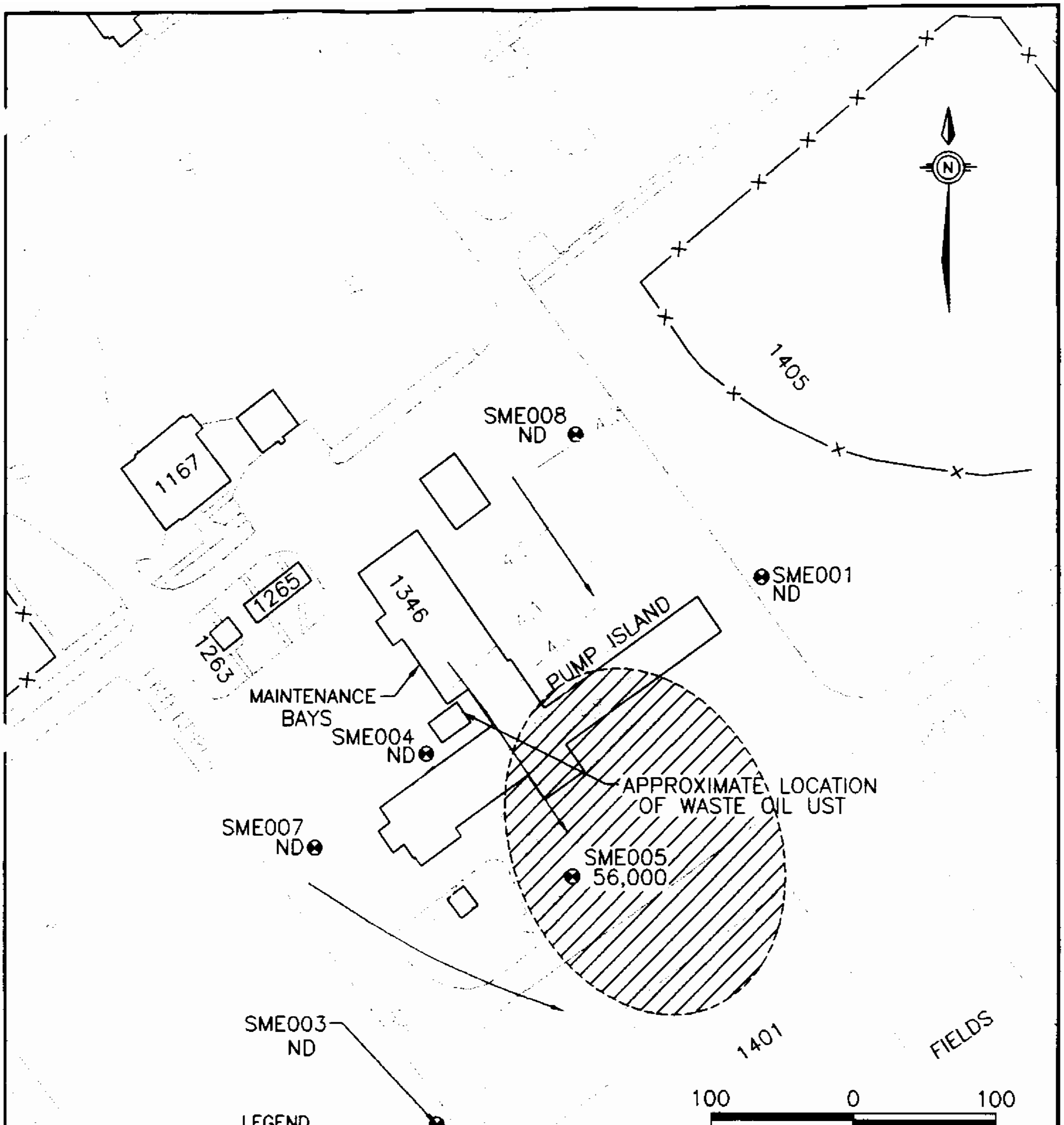
CHARLESTON, S.C.
FIGURE 10.5–11
ETHYLBENZENE IN
SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346
DWG DATE: 12/10/97
DWG NAME: 2906ETHY



LEGEND

- – ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- – CONTOUR INTERVAL – 0.1 FOOT
- – FLOW DIRECTION
- – < 75 μg/L
- – > 75 μg/L
- – APPROXIMATE EXTENT

NOTES:
- 75 μg/L = TAP RBC FOR TOLUENE (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN μg/L

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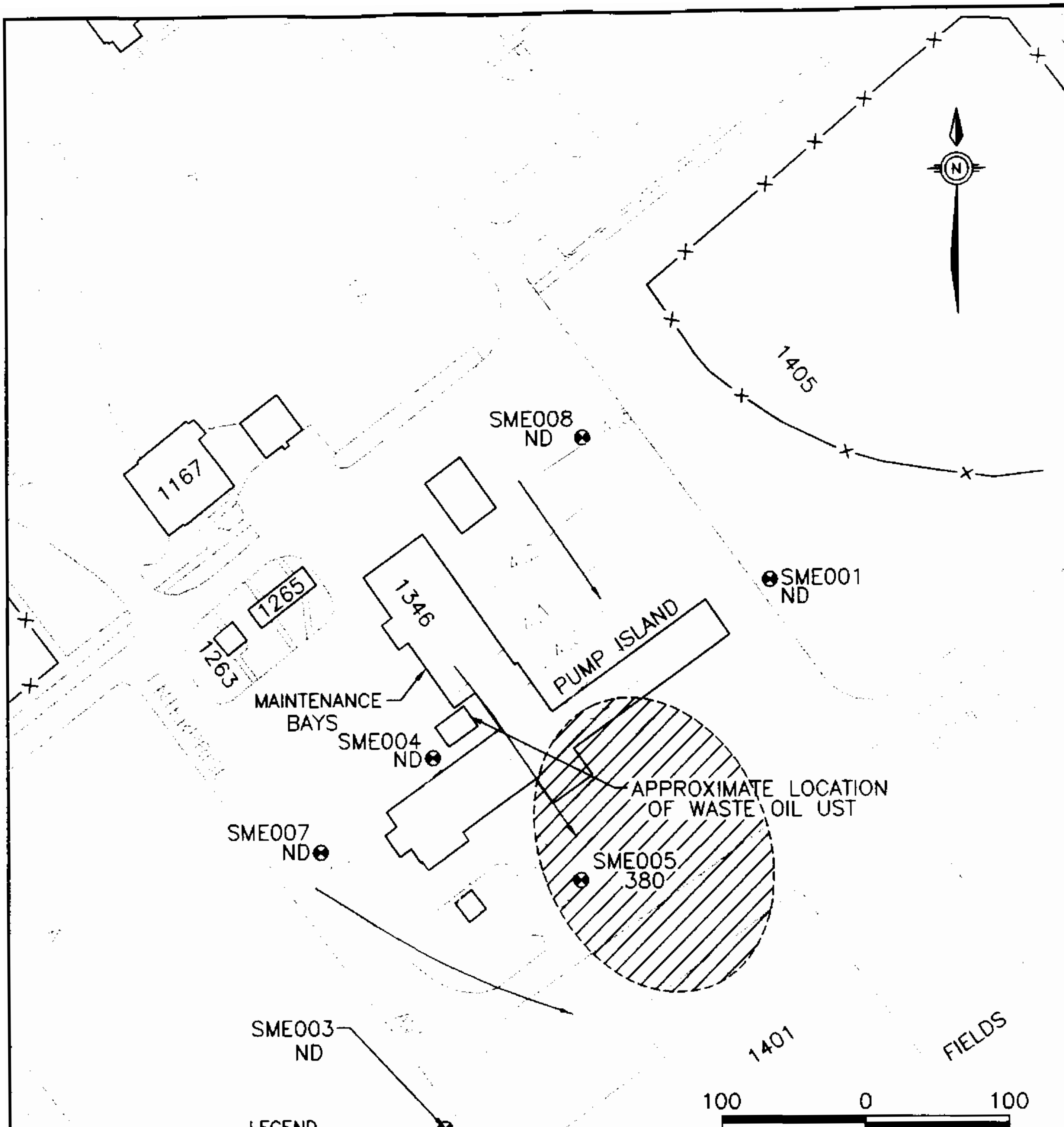
FIGURE 10.5–12
TOLUENE IN SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906TOLU



LEGEND

- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 0.1 FOOT
- FLOW DIRECTION
- < 73 μg/L
- > 73 μg/L
- APPROXIMATE EXTENT

NOTES:
- 73 μg/L = TAP RBC FOR 2,4–DIMETHYLPHENOL (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN μg/L

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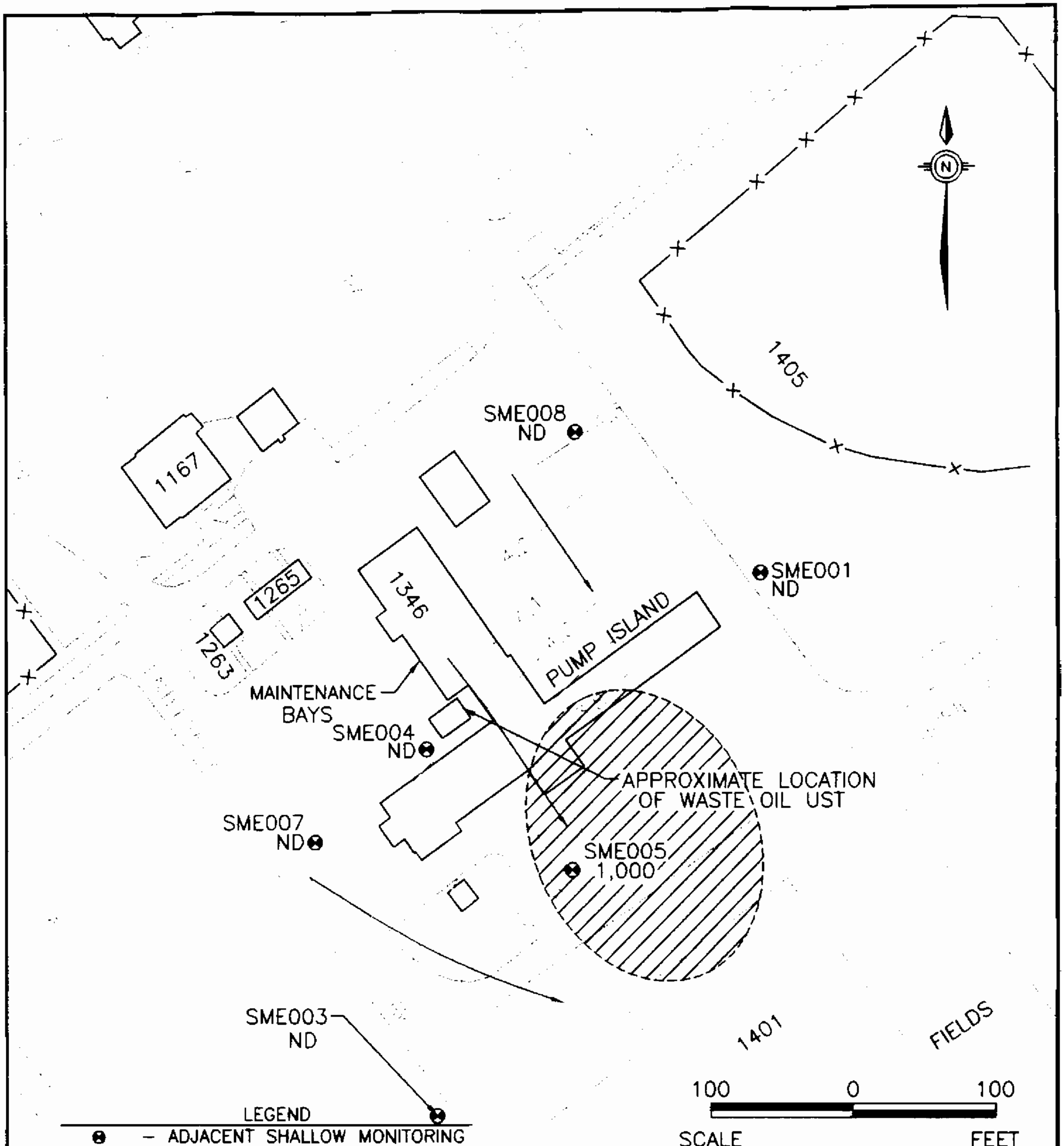
FIGURE 10.5–14
2,4–DIMETHYLPHENOL IN
SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97	DWG NAME: 2906DI24



LEGEND

- ⊗ – ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- – · – – CONTOUR INTERVAL – 0.1 FOOT
- ⟶ – FLOW DIRECTION
- ☐ – < 180 μg/L
- ▨ – > 180 μg/L
- ---- – APPROXIMATE EXTENT

NOTES:
- 180 μg/L = TAP RBC FOR 2-METHYLPHENOL (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN μg/L

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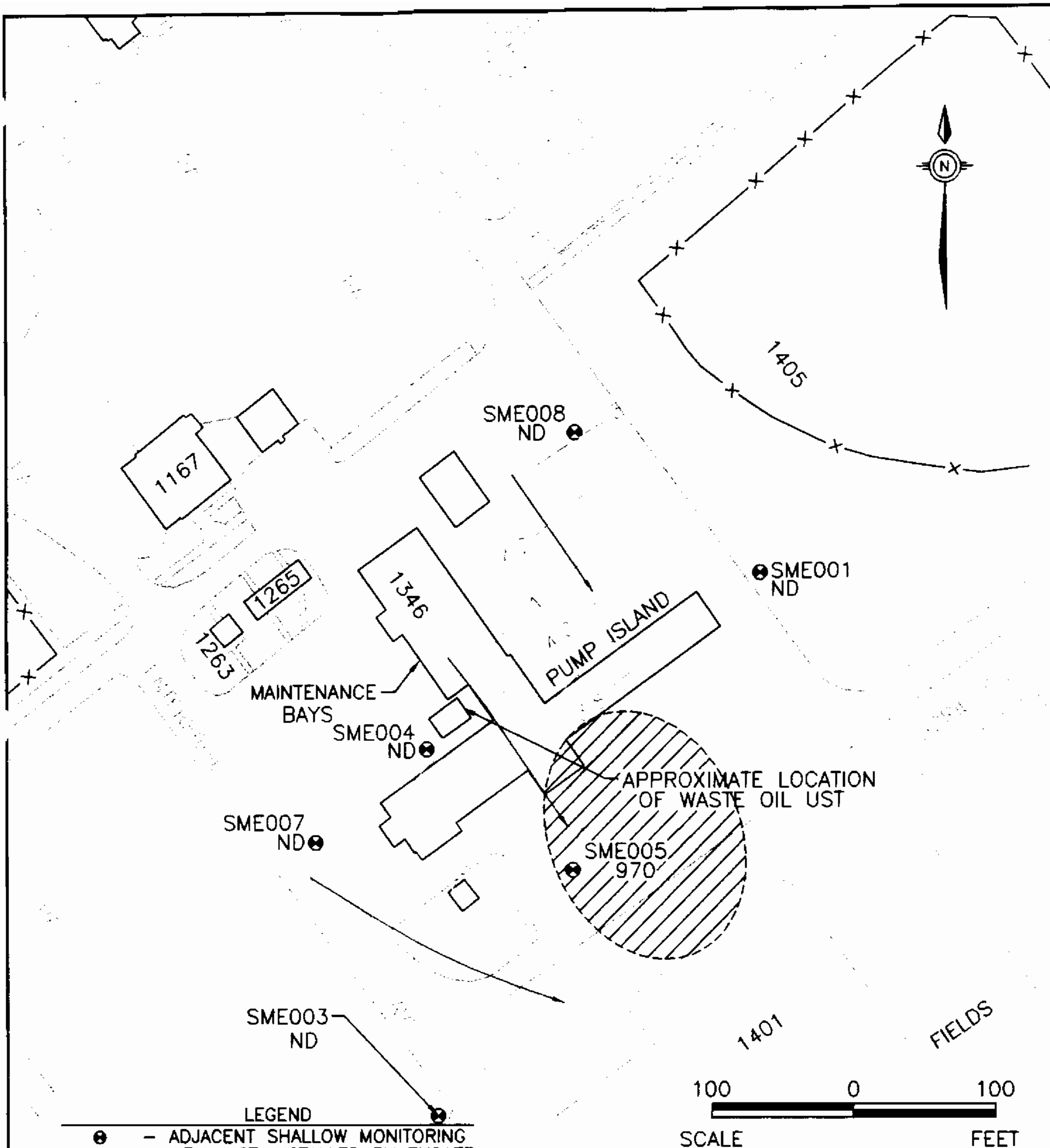
FIGURE 10.5-15
2-METHYLPHENOL IN
SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906MET2



LEGEND

- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 0.1 FOOT
- FLOW DIRECTION
- < 18 μg/L
- > 18 μg/L
- APPROXIMATE EXTENT

NOTES:

- 18 μg/L = TAP RBC FOR 4–METHYLPHENOL (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN μg/L

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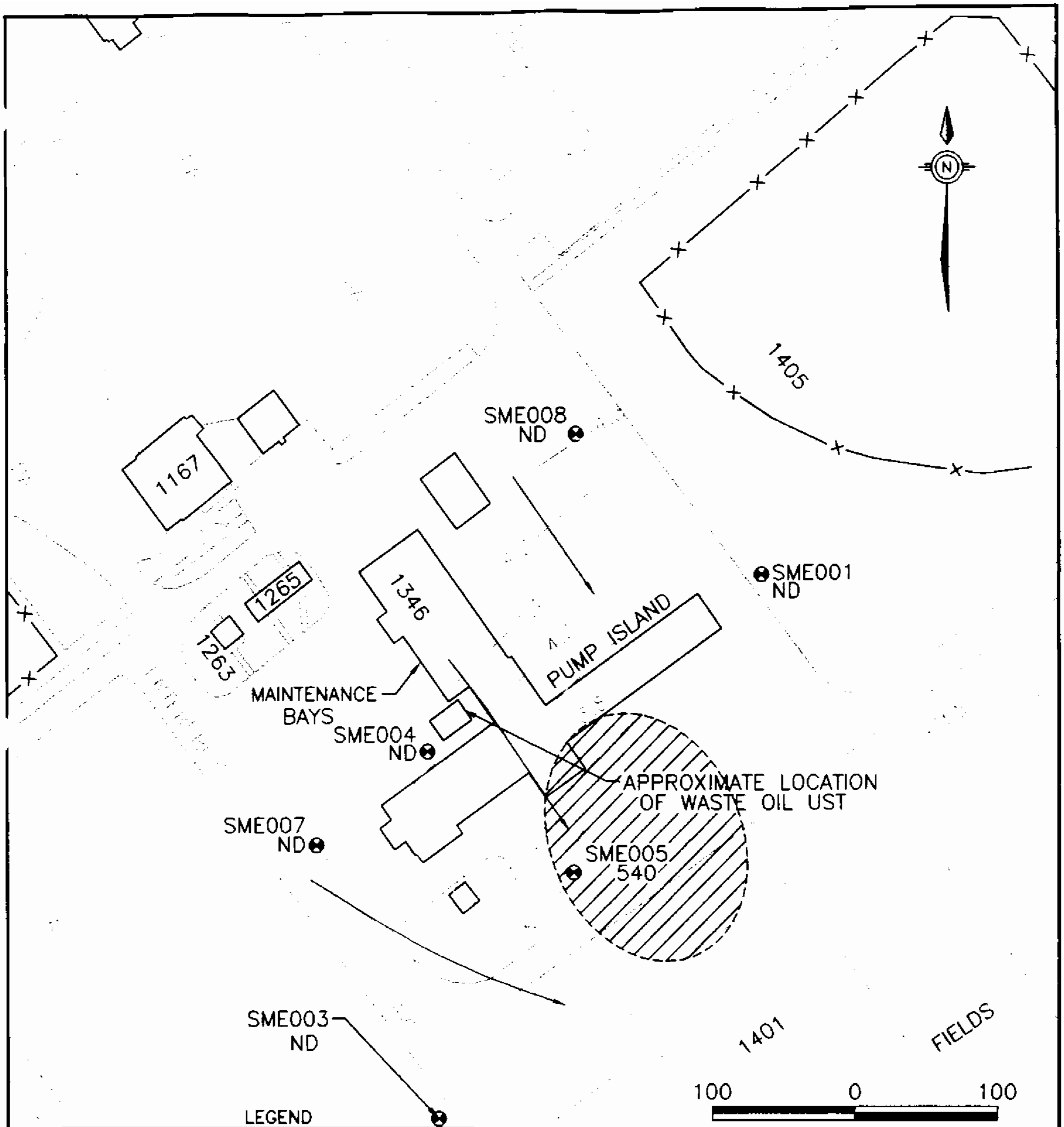
FIGURE 10.5–16
4–METHYLPHENOL IN
SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906MET4



LEGEND

- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 0.1 FOOT
- FLOW DIRECTION
- < 150 μg/L
- > 150 μg/L
- APPROXIMATE EXTENT

NOTES:
- 150 μg/L = TAP RBC FOR NAPTHALENE (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN μg/L

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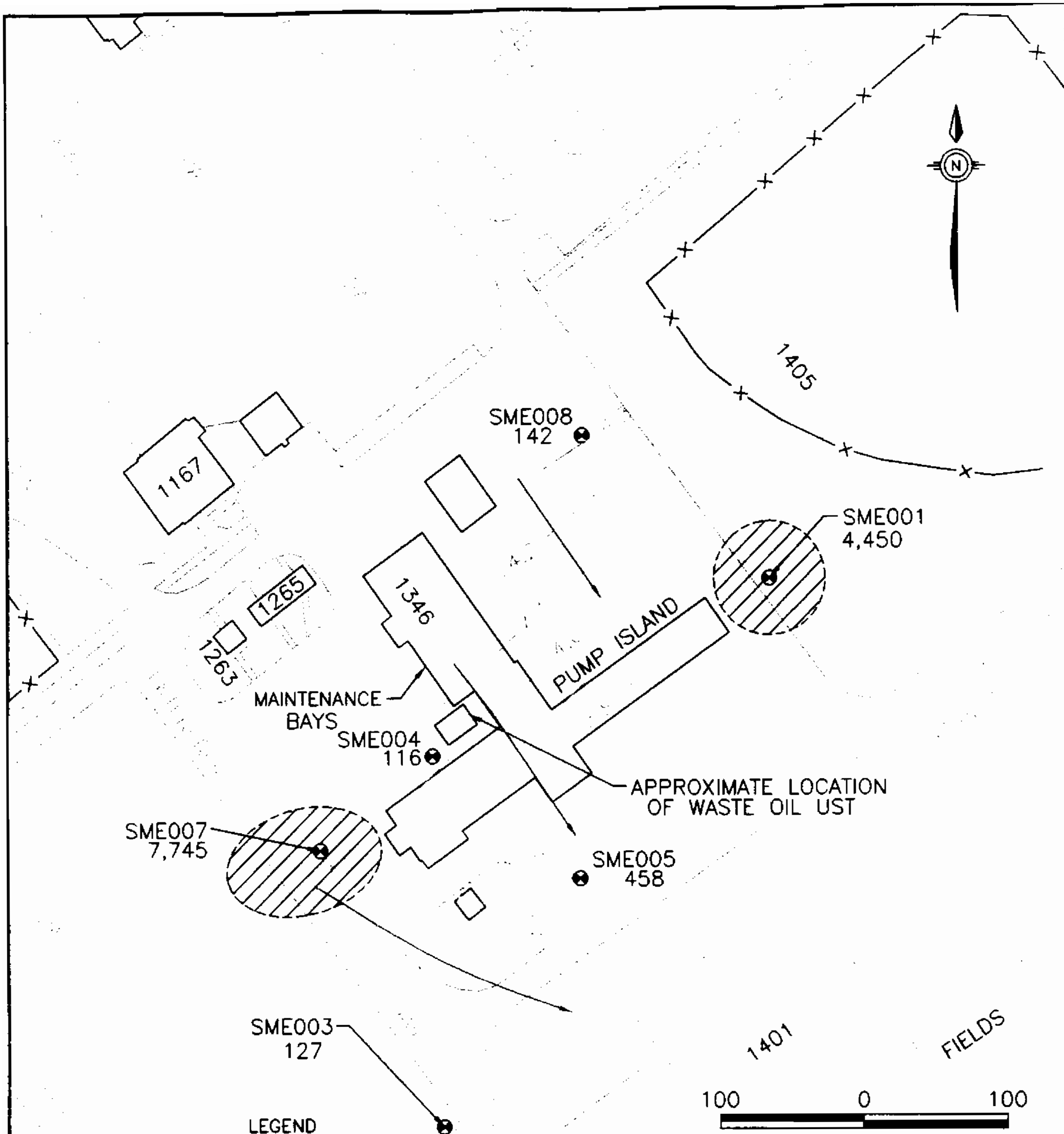
FIGURE 10.5–17
NAPTHALENE IN
SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906NAPT



LEGEND

- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 0.1 FOOT
- FLOW DIRECTION
- < 3,700 μg/L
- > 3,700 μg/L
- APPROXIMATE EXTENT

NOTES:
- 3,700 μg/L = TAP RBC FOR ALUMINUM (USEPA 1996b)
- ND = NOT DETECTED
- RESULTS IN μg/L

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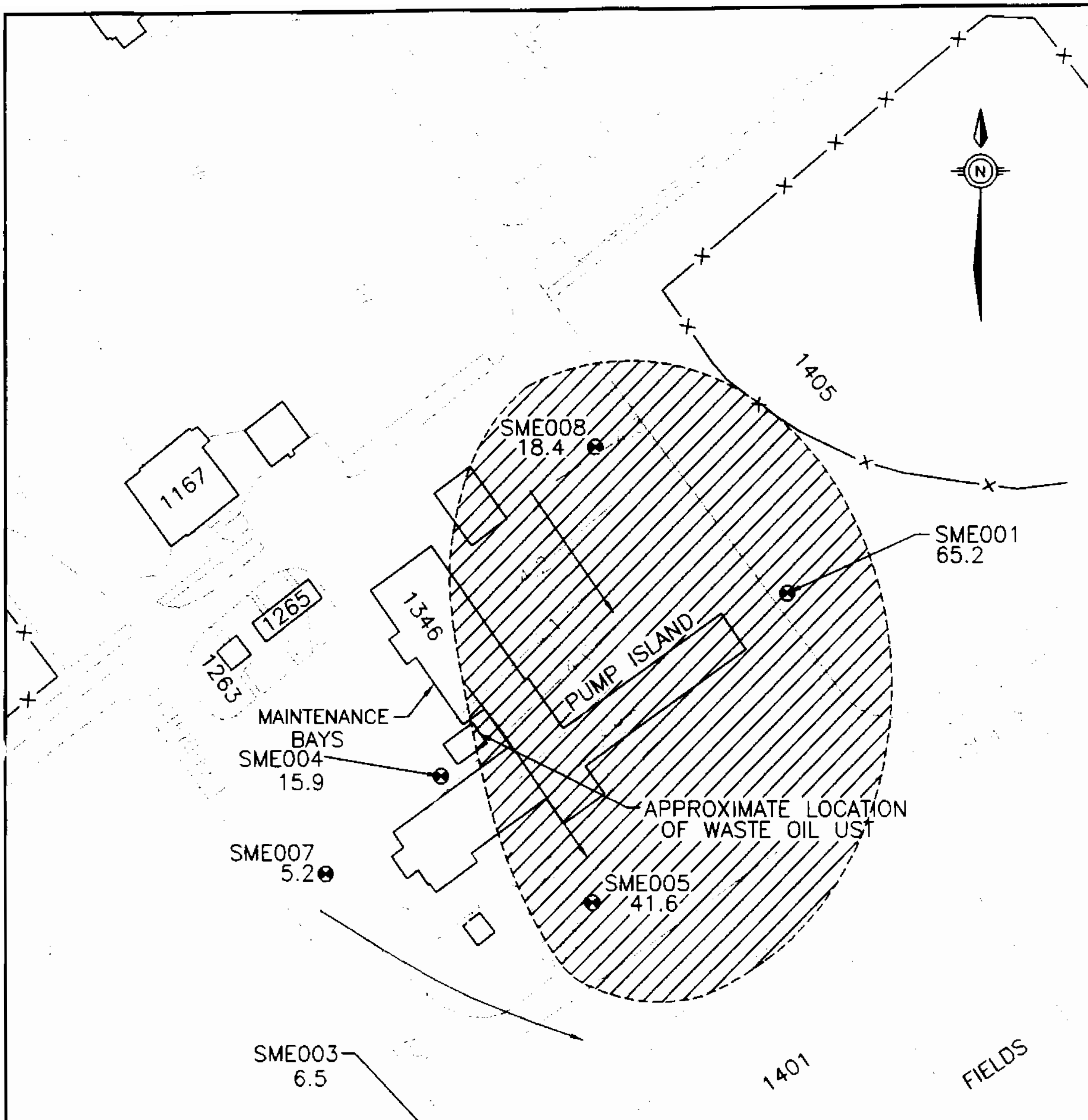
FIGURE 10.5–18
ALUMINUM IN
SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906ALUM



LEGEND

- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 0.1 FOOT
- FLOW DIRECTION
- < 16.7 μg/L
- > 16.7 μg/L
- APPROXIMATE EXTENT

NOTES:

- 16.7 μg/L = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN SHALLOW GROUNDWATER
- ND = NOT DETECTED
- RESULTS IN μg/L

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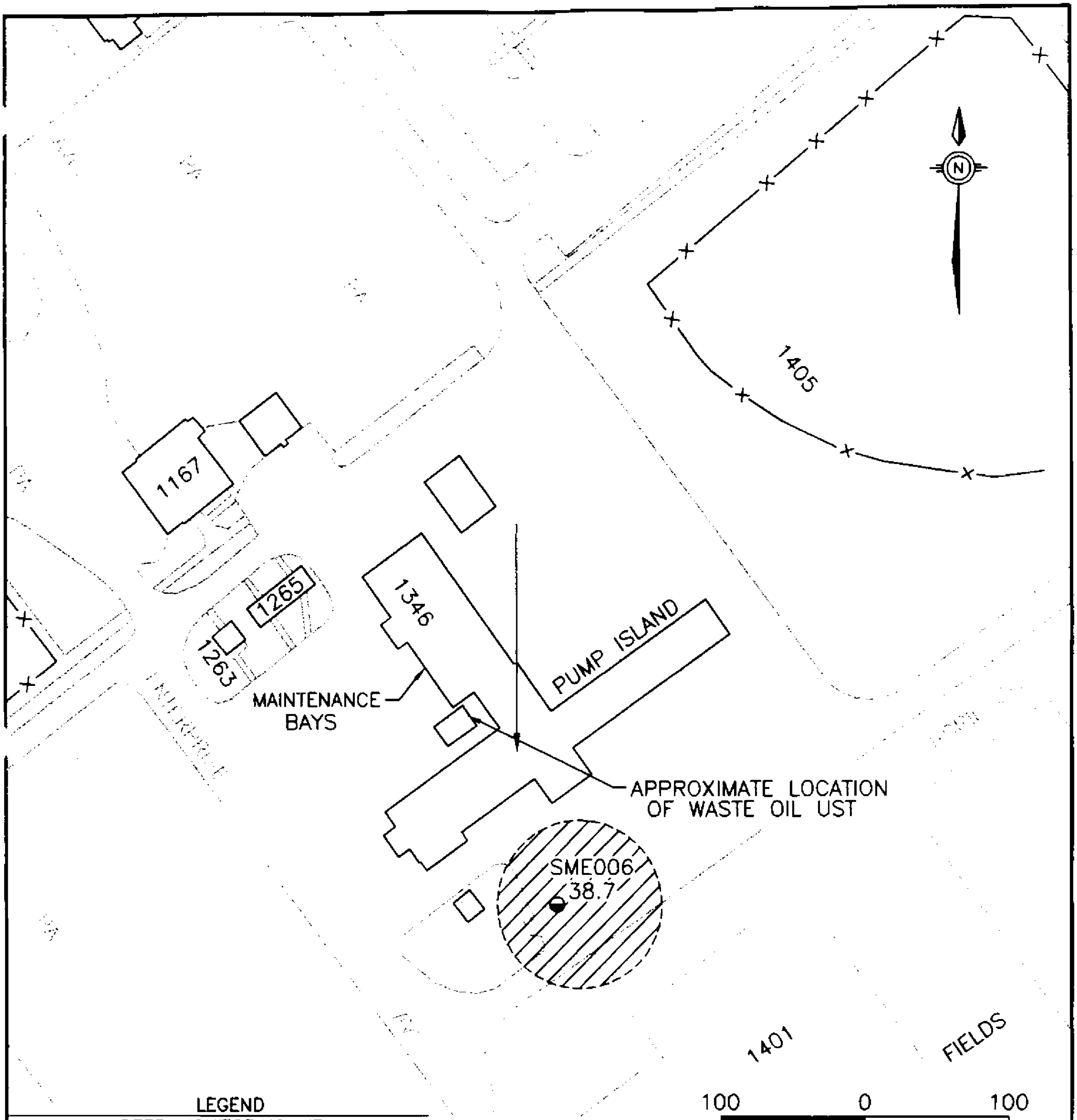
FIGURE 10.5–19
ARSENIC IN SHALLOW GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97 | DWG NAME: 2906ARSE



LEGEND

- DEEP MONITORING WELL
- FLOW DIRECTION
- < 16.2 µg/L
- > 16.2 µg/L
- APPROXIMATE EXTENT

NOTES:
- 16.2 µg/L = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN DEEP GROUNDWATER
- ND = NOT DETECTED
- RESULTS IN µg/L
- WELL SME006 INSTALLED IN DEEPER PORTION OF SURFICIAL AQUIFIER

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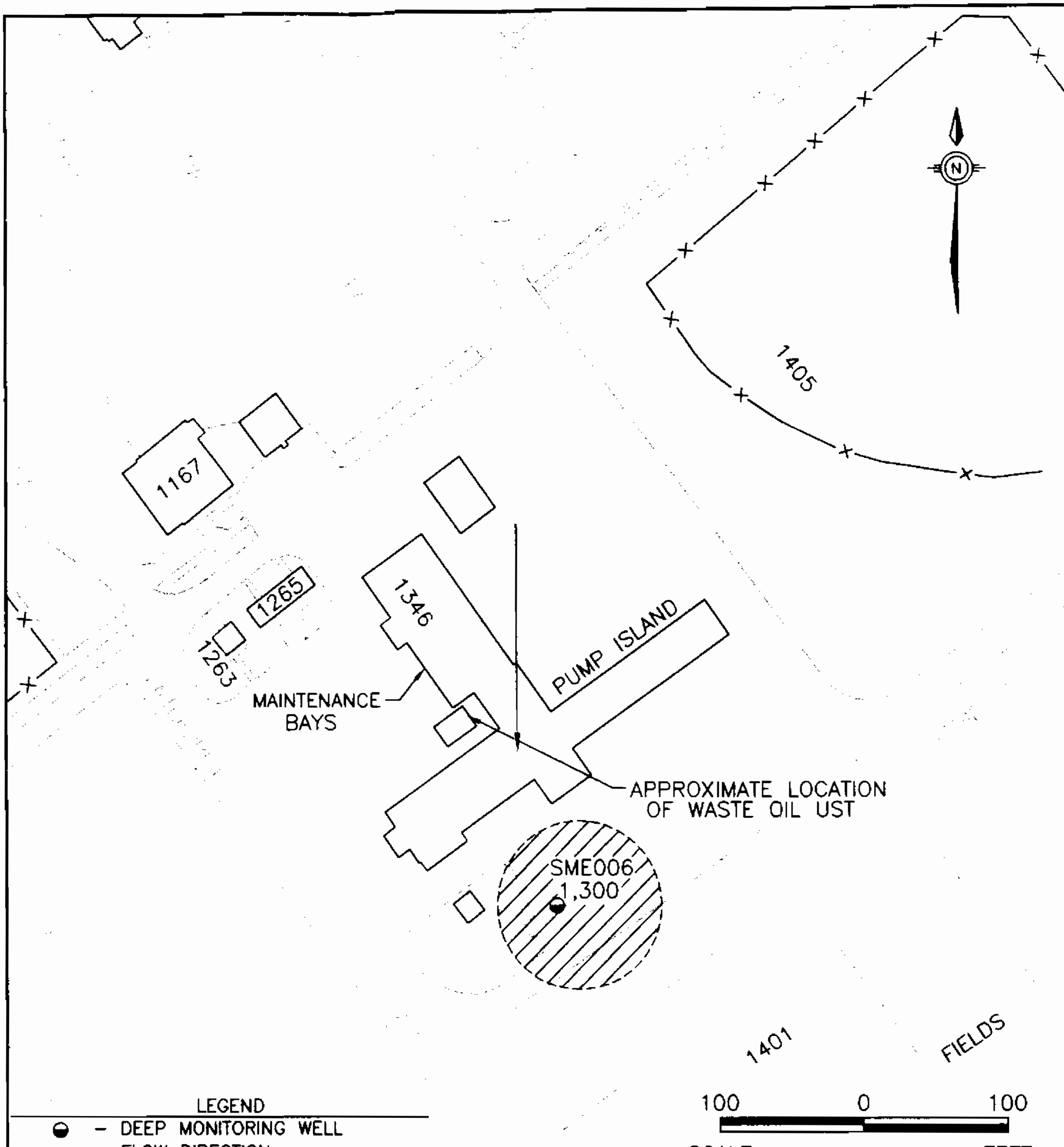
FIGURE 10.5-20
ARSENIC IN DEEP GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/10/97	DWG NAME: 2906DPAG



LEGEND

- DEEP MONITORING WELL
- FLOW DIRECTION
- < 1,260 µg/L
- > 1,260 µg/L
- APPROXIMATE EXTENT

NOTES:

- 1,260 µg/L = ZONE F BACKGROUND CONCENTRATION FOR MANGANESE IN DEEP GROUNDWATER
- ND = NOT DETECTED
- RESULTS IN µg/L
- WELL SME006 INSTALLED IN DEEPER PORTION OF SURFICIAL AQUIFIER

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FIGURE 10.5-21
MANGANESE IN DEEP GROUNDWATER
AOC #609
SERVICE STATION, BUILDING 1346

DWG DATE: 12/11/97 | DWG NAME: 2906MIGW

The concentrations of arsenic and manganese detected in the deep groundwater sample exceeded the respective RBCs and Zone F background concentration during first quarter sampling. Figures 10.5-20 and 10.5-21 presents the distribution of arsenic and manganese in deep groundwater at AOC 609.

10.5.5 Fate and Transport Assessment for AOC 609

Environmental media sampled as part of the AOC 609 investigation include surface soil, subsurface soil, and shallow and deep groundwater. Potential constituent migration pathways investigated for AOC 609 include soil-to-groundwater, groundwater-to-surface water, and emission of volatiles from surface soil-to-air.

10.5.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.5.9 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

No organic constituents were detected in AOC 609 surface or subsurface soil above groundwater protection SSLs. Therefore, even though a number of organics were present in surface and subsurface soil above analytical detection limits, their leachability to groundwater is expected to be insignificant.

Table 10.5.9
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 609
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Subsurfac Soil	Max. Concentration Shallow GW	Deep GW	Screening Concentration * Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	860	ND	ND	ND	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
Acrolein	89	NA	ND	ND	2940	730	0.55	UG/KG	UG/L	NO	NO	NO
Benzene	ND	ND	34000	ND	30	0.36	109	UG/KG	UG/L	NO	YES	YES
2-Butanone (MEK)	8	7	ND	ND	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	3	ND	ND	ND	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	ND	ND	11	ND	1000	39	105	UG/KG	UG/L	NO	NO	NO
1,1-Dichloroethene	4	ND	ND	ND	23000	810	NA	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	ND	ND	2400	ND	13000	1300	4.3	UG/KG	UG/L	NO	YES	YES
Toluene	ND	ND	56000	ND	12000	750	37	UG/KG	UG/L	NO	YES	YES
Trichloroethene	4	7	ND	ND	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
Xylene (total)	ND	ND	15000	ND	142000	12000	NA	UG/KG	UG/L	NO	YES	NO
Semivolatile Organic Compounds												
Benzoic acid	52	ND	420	ND	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	124	ND	ND	ND	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	150	ND	ND	ND	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	160	81	ND	ND	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	150	ND	ND	ND	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	135	ND	ND	ND	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	180	ND	ND	ND	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	60	ND	ND	ND	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	104	ND	ND	ND	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	ND	56	ND	ND	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	40	42	ND	ND	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
2,4-Dimethylphenol	ND	ND	380	ND	9000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	84	58	ND	ND	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	340	ND	ND	ND	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	55	ND	48	ND	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylphenol (o-cresol)	ND	ND	1000	ND	15000	1800	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	ND	970	ND	1380	180	NA	UG/KG	UG/L	NO	YES	NO
Naphthalene	ND	ND	540	ND	84000	1500	23.5	UG/KG	UG/L	NO	NO	YES
Phenanthrene	160	ND	ND	ND	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenol	ND	ND	810	ND	100000	22000	58	UG/KG	UG/L	NO	NO	YES
Pyrene	300	ND	ND	ND	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
4,4'-DDD	29	NA	ND	ND	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	84	NA	ND	ND	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.686	NA	ND	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	16700	9880	7750	ND	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	12.2	ND	ND	ND	5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	114	6.4	65.2	38.7	29	16.7	36	MG/KG	UG/L	YES	YES	YES
Barium	88.9	24.5	61.9	64.6	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1.45	ND	ND	ND	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.47	0.12	ND	ND	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	37.8	20.1	14.3	ND	38	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	18.5	2	2.8	1	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	120	ND	6.6	ND	920	1500	2.9	MG/KG	UG/L	NO	NO	YES
Cyanide	0.27	NA	8.8	ND	40	730	4.3	MG/KG	UG/L	NO	NO	YES
Lead	320	14.3	8.8	ND	400	15	8.5	MG/KG	UG/L	NO	NO	YES
Manganese	393	76.1	647	1300	1100	2010	NA	MG/KG	UG/L	NO	NO	NO

Table 10.5.9
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 609
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Mercury	0.45	0.06	0.22	ND	2	11	0.025	MG/KG	UG/L	NO	NO	YES
Nickel	28.4	3.4	5.6	9.3	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	ND	ND	13.5	ND	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	ND	ND	2.7	ND	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Tin	25	ND	ND	ND	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	44	28.4	19.3	ND	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	716	34.8	20.7	6.2	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background reference value.

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

Two inorganic constituents — antimony and arsenic — were detected in soil samples above their respective groundwater protection SSLs or background values. Specifically, antimony was detected above the SSL in only one surface soil sample, but was not detected in the associated subsurface sample. Arsenic was detected above screening criteria in all six surface soil samples, but was below the SSL in all subsurface soil samples. The absence of inorganic constituents in subsurface soil above SSLs invalidates the soil to groundwater pathway.

10.5.5.2 Groundwater-to-Surface Water Cross-Media Transport

Table 10.5.9 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to tap water RBCs and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) tap water RBCs, or (b) background concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

In three quarters of sampling data, five organics — benzene, ethylbenzene, toluene, xylenes, and 4-methylphenol — exceeded the RBC values, and five — benzene, ethylbenzene, toluene, napthalene, and phenol — exceeded the surface water chronic values. All of these exceedances were detected exclusively in shallow groundwater, thus focusing the evaluation and eliminating consideration of deep groundwater transport for organics. However, it should be considered that a downward potential for migration exists at Zone F (see Section 2) , and could be a factor in transport of AOC constituents downgradient of the site proper. Organic exceedances were limited horizontally to location SME005; this location, however, is the furthest downgradient and may indicate that organic contamination has migrated offsite. None of these compounds were detected in soil, indicating there is a lack of residual contaminant mass onsite contributing to groundwater contamination. However, the presence of residual contamination upgradient of location SME005 that has not been found due to sample point density is probable, particularly given that upgradient wells did not exhibit organic contamination. Trends in organics over the three sampling events indicate significant attenuation of those constituents exceeding RBCs, and of the analytes detected in the initial round, only benzene, toluene, and 4-methylphenol remained above the RBCs for the third quarter event. Similarly, those compounds above surface water criteria exhibited significant attenuation from first to third quarter; however , they all remained above the criteria for the third quarter event.

Arsenic was detected at concentrations in shallow and deep groundwater at four locations exceeding both the RBC and the surface water screening criteria. In addition, copper, cyanide, lead and mercury in shallow groundwater exceeded their respective surface water criteria. Without exception, the concentration of these constituents decreased with depth. There is no clear distributional trend of these constituents laterally across the site. Arsenic was the most frequently detected inorganic in groundwater, and, as noted, is the only inorganic that remains at significant concentrations (above screening criteria) in the deep zone. There were no clear trends in arsenic or copper concentrations over time: arsenic remained above the RBC in three of six shallow samples and above surface water criteria in two of six first quarter, one of six second quarter and two of six in third quarter samples, while copper remained above surface water criteria in one of four first quarter shallow samples and two of four second quarter and one of four third quarter samples. Lead and mercury exhibited a downward trend in three of four samples. Lead remained above surface water criteria in one of four during the three quarters. Given the lack of a clear source for these inorganics in groundwater, and particularly the somewhat ubiquitous occurrence of arsenic, consideration should be given that they fall within the range of ambient conditions, rather than relying on a singular threshold value to define contamination.

The groundwater migration pathway appears to have some merit with regard to organic and inorganic transport at levels exceeding both RBCs and surface water discharge criteria. However, the groundwater in the surficial aquifer is not currently used for consumption, nor is it anticipated to be used in the future, thus invalidating the risk-based exposure pathway. Additionally, the nearest surface water body is the Cooper River, which lies approximately 1,800 feet to the northeast, while groundwater at AOC 609 flows to the southeast (see Section 2). Consequently, there is no likelihood of site groundwater discharging to surface water within reasonable proximity at concentrations deleterious to ecological receptors.

10.5.5.3 AOC 609 — Soil-to-Air Cross-Media Transport

Table 10.5.10 lists the VOCs detected in surface soil samples collected at AOC 609, along with corresponding soil-to-air volatilization screening levels. Acrolein and 2-Butanone were present at levels exceeding volatilization criteria; however, the entire site is covered with pavement and/or structures which overly surface soil. Consequently, the soil-to-air migration pathway is insignificant at AOC 609.

10.5.5.4 AOC 609 — Fate and Transport Summary

No organic compounds were detected above applicable SSLs in either surface or subsurface soil. Further, two metals (arsenic and antimony) were present above SSLs in surface soil, but were below SSLs in subsurface soil. The lack of any constituents in subsurface soil above SSLs provide evidence that the soil-to-groundwater pathway at AOC 609 is invalid. Additionally, the entire site area is covered with buildings or asphalt, which eliminates precipitation as a leaching agent. Several organics were detected in groundwater above applicable RBCs and/or surface water protection values; these were restricted to one location (the furthest downgradient) and to shallow groundwater. In general, these constituents showed a decrease in concentration over three quarters of sampling, indicating the presence of a dynamic attenuation mechanism coupled with probable source diminishment. Four metals were detected in shallow groundwater and one (arsenic) was

Table 10.5.10
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone F: AOC 609
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	860	100000000	UG/KG	NO
Acrolein	89	NA	UG/KG	NO
2-Butanone (MEK)	8	10000	UG/KG	NO
Carbon disulfide	3	720000	UG/KG	NO
1,1-Dichloroethane	4	1300000	UG/KG	NO
Trichloroethene	4	5000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996. Value for 2-Butanone was estimated.

NA - Not available

present above screening criteria in both the shallow and deep groundwater. With the exception of one (lead), no clear temporal trends are notable. Given the lack of a source, and in particular the persistent occurrence of arsenic, consideration should be given that these concentrations are within the ambient range. The surficial groundwater pathway for risk-based exposure is invalid due to the non-use of groundwater. The nearest surface water is a significant distance away and is inconsistent groundwater flow direction from the site, and is therefore not considered significant with respect to this AOC.

10.5.6 Human Health Risk Assessment

10.5.6.1 Site Background and Investigative Approach

AOC 609 is the former gasoline station and automotive repair and maintenance shop at Building 1346. Nearly all of the site area is covered by the building and surrounding asphalt pavement. Materials released, stored, or disposed of at the site include gasoline, diesel fuel, motor/lubricating oils, degreasing solvents, antifreeze, and various automotive products.

Six soil samples were collected from each of the upper and lower intervals to identify potential impacts resulting from the activities listed above. Surface soil samples from all six boring locations were used to quantitatively assess soil exposure pathways. Six existing shallow and one deep monitoring well were sampled, and data from the first quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.5.3 and 10.5.4 summarizes the sampling effort for AOC 609 soil and groundwater.

10.5.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this CSI and presented in Table 10.5.11, BEQs, antimony, arsenic, beryllium, and manganese were identified as COPCs in surface soil.

Groundwater

As shown in Table 10.5.12, aluminum, arsenic, benzene, chlorobenzene, toluene, and xylene (total), 2,4-dimethylphenol, ethylbenzene, 2-methylphenol, 4-methylphenol, and naphthalene were identified as a COPCs for shallow groundwater at AOC 609.

10.5.6.3 Exposure Assessment

Exposure Setting

AOC 609 is in an urban setting on the former naval base, near the western boundary of the installation. The site is surrounded by a large asphalt parking lot to the west, grass-covered open fields to the south and east, and buildings to the north. Nearly 100 percent of the site area is covered by the building and surrounding pavement.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents, adolescent site trespassers, or future recreational users. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. Current exposure to workers is discussed qualitatively in relation to the future workers; future recreational users are addressed qualitatively in relation to future residents; and current adolescent trespassers are addressed qualitatively in relation to future site child residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (the paved surfacing would prevent direct contact to a portion of the site). Therefore, future worker assessment is considered to be conservatively representative of current site users. Similarly, the future site residential scenario is considered conservatively representative of the current trespasser and the future recreational scenarios.

Table 10.5.11
Chemicals Present in Site Samples
AOC 609 - Surface Soil
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Reference	Units	Number Exceeding RBC	Number Exceeding Ref.
Carcinogenic PAHs													
B(a)P Equiv.	*	3	6	44.0515	261.88	118	439.09	473.755	88	NA	UG/KG	1	
Benzo(a)anthracene		1	6	150	150	150	190	230	880	NA	UG/KG		
Benzo(b)fluoranthene		1	6	150	150	150	190	230	880	NA	UG/KG		
Chrysene		2	6	51.5	180	116	190	230	88000	NA	UG/KG		
Dibenz(a,h)anthracene		1	6	60	60	60	190	230	88	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		1	6	103.5	103.5	104	190	230	880	NA	UG/KG		
Benzo(k)fluoranthene		1	6	135	135	135	190	230	8800	NA	UG/KG		
Benzo(a)pyrene	*	3	6	44	160	84	190	205	88	NA	UG/KG	1	
TCDD Equivalents													
Dioxin Equiv.		3	3	0.0648	0.6856	0.40	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		3	3	3.13	15.4	11	NA	NA	NA	NA	NG/KG		
123478-HxCDD		1	3	0.19	0.19	0.19	0.0835	0.1395	NA	NA	NG/KG		
123678-HxCDD		1	3	0.375	0.375	0.38	0.0605	0.101	NA	NA	NG/KG		
123789-HxCDD		1	3	0.866	0.866	0.87	0.063	0.1055	NA	NA	NG/KG		
234678-HxCDF		3	3	0.335	0.837	0.56	NA	NA	NA	NA	NG/KG		
123478-HxCDF		2	3	0.842	0.848	0.85	0.037	0.037	NA	NA	NG/KG		
OCDD		2	3	173	220	197	2.03	2.03	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		6	6	4620	16650	9748	NA	NA	7800	18500	MG/KG	5	
Antimony (Sb)	*	1	6	12.2	12.2	12.20	0.17	0.75	3.1	0.79	MG/KG	1	1
Arsenic (As)	*	6	6	2.9	113.8	25.73	NA	NA	0.43	19.9	MG/KG	6	1
Barium (Ba)		6	6	16.4	88.85	42.48	NA	NA	550	61.5	MG/KG		1
Beryllium (Be)	*	4	6	0.58	1.45	0.92	0.185	0.2	0.15	1.05	MG/KG	4	1
Cadmium (Cd)		4	6	0.08	0.47	0.26	0.025	0.025	3.9	0.26	MG/KG		2
Calcium (Ca)	N	6	6	673.5	33900	10990	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		6	6	4.1	37.8	20.77	NA	NA	39	34.8	MG/KG		1
Cobalt (Co)		5	6	3.5	18.5	9.59	0.455	0.455	470	15.1	MG/KG		1
Copper (Cu)		3	6	40.4	119.8	69.70	0.7	16.1	310	48.2	MG/KG		2
Cyanide (CN)		2	3	0.13	0.27	0.20	0.055	0.055	160	0.29	MG/KG		
Iron (Fe)	N	6	6	3120	22050	13345	NA	NA	NA	NA	MG/KG		
Lead (Pb)		6	6	10.5	320	110	NA	NA	400	180	MG/KG		1
Magnesium (Mg)	N	6	6	303.5	2490	1468	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	6	6	65.8	392.5	204	NA	NA	180	307	MG/KG	3	1
Mercury (Hg)		5	6	0.06	0.45	0.22	0.02	0.02	2.3	0.62	MG/KG		
Nickel (Ni)		6	6	2.4	28.4	12.76	NA	NA	160	12.6	MG/KG		2
Potassium (K)	N	5	6	445	1390	817	113.5	113.5	NA	NA	MG/KG		
Tin (Sn)		2	6	19.25	25	22.13	0.5	4.65	4700	9.38	MG/KG		2
Vanadium (V)		6	6	6.15	44	27.19	NA	NA	55	48.9	MG/KG		
Zinc (Zn)		5	6	120	715.5	291	4.6	4.6	2300	198	MG/KG		3
Pesticides													
4,4'-DDD		2	3	3.9	29	16.45	1.4	1.4	2700	NA	UG/KG		
4,4'-DDE		3	3	4.4	84	34.47	NA	NA	1900	NA	UG/KG		
Semivolatile Organics													
Benzo(g,h,i)perylene		2	6	44	123.5	83.75	190	230	310000	NA	UG/KG		
Benzoic acid		1	6	52	52	52	950	1100	31000000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate		3	6	43	84	64	190	230	46000	NA	UG/KG		
Di-n-butylphthalate		1	6	40	40	40	190	230	780000	NA	UG/KG		
Fluoranthene		2	6	54	340	197	190	230	310000	NA	UG/KG		
2-Methylnaphthalene		1	6	55	55	55	190	230	310000	NA	UG/KG		
Phenanthrene		2	6	59.5	160	109.75	190	230	310000	NA	UG/KG		
Pyrene		2	6	52.5	300	176.25	190	230	230000	NA	UG/KG		

Table 10.5.11
Chemicals Present in Site Samples
AOC 609 - Surface Soil
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Reference	Units	Number Exceeding RBC	Ref.
Volatile Organics												
Acetone	2	6	62	860	461	6	70	780000	NA	UG/KG		
Acrolein	2	3	48	89	68.5	30	30	160000	NA	UG/KG		
2-Butanone	2	6	7	8	7.5	6	80	4700000	NA	UG/KG		
Carbon disulfide	3	6	2	3	2.67	3	3.5	780000	NA	UG/KG		
1,1-Dichloroethene	1	6	4	4	4	3	3.5	1100	NA	UG/KG		
Trichloroethene	2	6	2	4	3	3	3.5	58000	NA	UG/KG		

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram
NA - Not applicable

Table 10.5.12
Chemical Present in Site Samples
AOC 609 - Groundwater
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Screening Concentration Reference	Units	Number Exceeding RBC	Number Exceeding Ref.
Inorganics													
Aluminum (Al)	*	6	7	116	7745	2173	18	18	3700	224	UG/L	2	3
Arsenic (As)	*	7	7	5.2	65.2	27.36	NA	NA	0.045	16.7	UG/L	7	4
Barium (Ba)		7	7	5.9	64.6	36.73	NA	NA	260	94.3	UG/L		
Calcium (Ca)	N	7	7	1720	246000	52404	NA	NA	NA	NA	UG/L		
Chromium (Cr)		2	7	12.65	14.3	13.48	0.8	0.8	18	2.05	UG/L		2
Cobalt (Co)		5	7	1	2.8	1.76	0.9	0.9	220	10.9	UG/L		
Copper (Cu)		1	7	6.6	6.6	6.6	0.6	5.2	150	NA	UG/L		
Cyanide (CN)		5	7	2	8.8	3.76	2	2	73	3.3	UG/L		1
Iron (Fe)	N	7	7	1090	27300	10331	NA	NA	NA	NA	UG/L		
Lead (Pb)		3	7	6.2	8.8	7.67	1.7	1.7	15	NA	UG/L		
Magnesium (Mg)	N	7	7	1570	136000	43370	NA	NA	NA	NA	UG/L		
Manganese (Mn)		7	7	29.2	1300	348.8	NA	NA	84	2010	UG/L	4	
Mercury (Hg)		3	7	0.17	0.22	0.187	0.1	0.1	1.1	NA	UG/L		
Nickel (Ni)		6	7	0.93	9.3	3.32	0.4	0.4	73	5.55	UG/L		2
Potassium (K)	N	6	7	5310	65300	21259	1600	1600	NA	NA	UG/L		
Selenium (Se)		2	7	4.1	13.5	8.8	2.8	2.8	18	NA	UG/L		
Silver (Ag)		1	7	2.7	2.7	2.7	1.2	1.2	18	NA	UG/L		
Sodium (Na)	N	7	7	68000	1410000	567071	NA	NA	NA	NA	UG/L		
Vanadium (V)		5	7	1.2	19.3	7.38	0.5	0.5	26	1.58	UG/L		3
Zinc (Zn)		3	7	6.2	20.65	13.48	5.3	20.8	1100	NA	UG/L		
Semivolatile Organics													
Benzoic acid		2	7	1	420	210.5	50	50	15000	NA	UG/L		
2,4-Dimethylphenol	*	1	7	380	380	380	10	10	73	NA	UG/L	1	
2-Methylnaphthalene		1	7	48	48	48	10	10	150	NA	UG/L		
2-Methylphenol	*	1	7	1000	1000	1000	10	10	180	NA	UG/L	1	
4-Methylphenol	*	1	7	970	970	970	10	10	18	NA	UG/L	1	
Naphthalene	*	1	7	540	540	540	10	10	150	NA	UG/L	1	
Phenol		1	7	810	810	810	10	10	2200	NA	UG/L		
Volatile Organics													
Benzene	*	1	7	34000	34000	34000	5	5	0.36	NA	UG/L	1	
Chlorobenzene	*	1	7	11	11	11	5	2500	3.9	NA	UG/L	1	
Ethylbenzene	*	1	7	2400	2400	2400	5	5	130	NA	UG/L	1	
Toluene	*	1	7	56000	56000	56000	5	5	75	NA	UG/L	1	
Xylene (Total)	*	1	7	15000	15000	15000	5	5	1200	NA	UG/L	1	

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - micrograms per liter
NA - Not applicable

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The groundwater pathway for the hypothetical future site residents is incidental ingestion and inhalation of groundwater. The exposure pathways for future site workers are the same as those for the future site residents. For the soil pathways, uniform exposure was assumed for all sample locations. Table 10.5.13 presents the justification for exposure pathways assessed in this HHRA.

Table 10.5.13
Exposure Pathways Summary — AOC 609
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Worker/Trespasser)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 609.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 609.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.

Table 10.5.13
Exposure Pathways Summary — AOC 609
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses			
Future Site Residents, Site Worker, Recreational User	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at AOC 609. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Volatile COPCs were identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

Since less than ten surface soil samples were collected, maximum detected concentrations were used as EPCs, as discussed in Section 7 of this RFI. Maximum detected concentrations reported in the first-quarter sampling event were used as EPCs for groundwater.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.5.14 and 10.5.15, respectively.

Groundwater

CDIs for the groundwater pathway are shown in Table 10.5.16.

10.5.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.5.17 presents toxicological information specific to each COPC identified at AOC 609. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation and indicates aluminum could affect the uptake of other chemicals. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen, et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based secondary MCL (SMCL) for drinking water is 50 to 200 μg/L.

Table 10.5.14
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics							
Antimony	1	12.2	1.67E-05	1.56E-04	1.91E-05	5.97E-06	2.13E-06
Arsenic	1	113.8	1.56E-04	1.45E-03	1.78E-04	5.57E-05	1.99E-05
Beryllium	1	1.45	1.99E-06	1.85E-05	2.27E-06	7.09E-07	2.53E-07
Manganese	1	392.5	5.38E-04	5.02E-03	6.14E-04	1.92E-04	6.86E-05
Semivolatile Organics							
Benzo(a)pyrene Equivalen	1	0.26	3.56E-07	3.32E-06	4.07E-07	1.27E-07	4.54E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.5.15
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics								
Antimony	12.2	1	0.001	6.85E-07	2.26E-06	4.29E-07	4.89E-07	1.75E-07
Arsenic	113.8	1	0.001	6.39E-06	2.11E-05	4.00E-06	4.57E-06	1.63E-06
Beryllium	1.45	1	0.001	8.14E-08	2.69E-07	5.10E-08	5.82E-08	2.08E-08
Manganese	392.5	1	0.001	2.20E-05	7.28E-05	1.38E-05	1.57E-05	5.62E-06
Semivolatile Organics								
Benzo(a)pyrene Equivalen	0.26	1	0.01	1.46E-07	4.82E-07	9.14E-08	1.04E-07	3.73E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.5.16
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics						
Aluminum (Al)	7.745	2.12E-01	4.95E-01	1.17E-01	7.58E-02	2.71E-02
Arsenic (As)	0.0652	1.79E-03	4.17E-03	9.82E-04	6.38E-04	2.28E-04
Semivolatile Organics						
2,4-Dimethylphenol	0.38	1.04E-02	2.43E-02	5.73E-03	3.72E-03	1.33E-03
2-Methylphenol	1	2.74E-02	6.39E-02	1.51E-02	9.78E-03	3.49E-03
4-Methylphenol	0.97	2.66E-02	6.20E-02	1.46E-02	9.49E-03	3.39E-03
Naphthalene	0.54	1.48E-02	3.45E-02	8.14E-03	5.28E-03	1.89E-03
Volatile Organics						
Benzene	34	9.32E-01	2.17E+00	5.12E-01	3.33E-01	1.19E-01
Chlorobenzene	0.011	3.01E-04	7.03E-04	1.66E-04	1.08E-04	3.84E-05
Ethylbenzene	2.4	6.58E-02	1.53E-01	3.62E-02	2.35E-02	8.39E-03
Toluene	56	1.53E+00	3.58E+00	8.44E-01	5.48E-01	1.96E-01
Xylene (total)	15	4.11E-01	9.59E-01	2.26E-01	1.47E-01	5.24E-02

NOTES:

lwa Lifetime weighted average
CDI Chronic Daily Intake
H-CDI Noncarcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.5.17
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 609
NAVBASE Charleston, Zone F
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
emical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
minum	1	d	NA	NA	NA	NA		NA	NA	NA	NA		NA		NA	NA
imony	0.0004	a	L	whole body/blood increased mortality	1,000	NA		NA	NA	NA	NA		NA		D	NA
enic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
izene	NA		NA	NA	NA	0.00171	e	NA	NA	NA	0.029	a	0.029	a	A	leukemia
izo(a)pyrene Equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	6.1	e	B2	mutagen
yllium	0.005	a	L	microscopic organ changes	100	NA		NA	NA	NA	4.3	a	8.4	a	B2	osteosarcoma
orobenzene	0.02	a	M	liver changes	1,000	0.00571	c	NA	NA	10000	NA		NA		D	NA
-Dimethylphenol	0.02	a	L	clinical signs and hematological changes	3000	NA		NA	NA	NA	NA		NA		NA	NA
ylbenzene	0.1	a	L	liver and kidney toxicity	1000	0.286	a	L	developmental toxicity	300	NA		NA		D	NA
nganese (food)	0.047	a	NA	neurological effects	1	NA		NA	NA	NA	NA		NA		D	NA
nganese (water)	0.023	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000	NA		NA		D	NA
lethylphenol	0.05	a	M	whole body decreased weight/CNS	1000	NA		NA	NA	NA	NA		NA		D	NA
lethylphenol	0.005	b	NA	CNS/respiratory distress	1,000	NA		NA	NA	NA	NA		NA		D	NA
hthalene	0.04	e	NA	NA	NA	NA		NA	NA	NA	NA		NA		D	NA
uene	0.2	a	NA	NA	NA	0.114	a	NA	NA	NA	NA		NA		D	NA
ene (total)	2	a	M	hyperactivity, decreased body weight	100	2		NA	NA	NA	NA		NA		D	NA

er:

= Integrated Risk Information System (IRIS)
= Health Effects Assessment Summary Tables (HEAST)
= HEAST alternative method
= EPA NCEA - Cincinnati (provisional)
= Withdrawn from IRIS/HEAST
= Not applicable or not available
= High confidence
= Low confidence
= Medium confidence

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaassen, et al., 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1,000, and a modifying factor of 1 (IRIS, 1995).

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. As listed in IRIS the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Benzene is a VOC which has been associated with leukemia. This chemical has been used as a solvent in coal tar naphtha, rubber, and plastic cement. USEPA lists benzene as a group A carcinogen. In large doses, benzene depresses the central nervous system, and chronic exposure depresses bone marrow. The oral SF for benzene was set by USEPA as 2.9E-02 $(mg/kg\text{-}day)^{-1}$; an oral RfD has not been set. Occupational inhalation exposure to benzene is acceptable by the OSHA at concentrations of 3.25 mg/m^3 or 1 ppm in air (Dreisbach et al; 1987; NIOSH, 1990).

BEQs include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\text{-}day)^{-1}$. TEF, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

phenolic radical, and partly from derangements in carbohydrate metabolism. Methemoglobinemia may also occur, especially after administration of hydroquinone. Other clinical signs are lethargy, prostration, and ataxia, as well as hematological changes. 2,4-Dimethylphenol is a possible carcinogen, which has been issued an RfDo of 2E-02 mg/kg-day (Dreisbach, et al., 1987).

Ethylbenzene is a colorless liquid that smells like gasoline. Acute inhalation exposure of humans to ethylbenzene irritates the eyes and lungs (Angerer and Wulf, 1985; Thienes and Haley, 1972). In addition, neurological effects such as dizziness have been reported in humans following acute inhalation exposure to this chemical. Similarly, respiratory and neurological effects have been observed in animals exposed to ethylbenzene via inhalation. No adverse health effects have been reported from a long-term (20 years) study of 200 workers occupationally exposed to ethylbenzene (Bardodej and Cirek, 1988). Laboratory tests on rats via oral exposure indicated a significant increase in total malignant tumors in females and combined male and female groups over two years (Maltoni et al., 1985). USEPA ranked ethylbenzene as unclassifiable with regard to human carcinogenicity, Group D (IRIS, 1993). Ethylbenzene has been issued an RfDo of 1E-01 and an RfDi of 2.86E-01 by USEPA (IRIS, 1996)

Manganese is an essential nutrient, but chronic exposure (0.8mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). The body is roughly twice as efficient absorbing manganese in water compared to manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

2-Methylphenol is one of three isomers of methyl phenol. Methylphenol is also known as cresol, hydroxytoluene, or cresylic acid. The common name for 2-methylphenol is ortho-cresol (o-cresol). Effects associated with acute exposure to cresols in humans include irritation and burning of skin, eyes, mouth, and throat, abdominal pain and vomiting, hemolytic anemia, kidney damage, facial paralysis, coma, and death. Exposure levels associated with human deaths have not been reliably reported, however, crude estimates based on accidental or intentional ingestion of cresol, the lethal oral exposure level for humans appeared to be at or above 2 g/kg (Chan et al., 1971). Autopsies of people who died following cresol exposure revealed gross lesions in the lungs, pancreas, liver, and kidneys, although these data cannot be considered reliable indicators of target organ effects. Studies in animals have shown that cresols can be lethal when exposure is through the inhalation, oral, or dermal routes. 2-Methylphenol is classified "C" in USEPA's weight of evidence. An RfDo of 5.0E-02 has been issued for 2-methylphenol (IRIS, 1996).

4-Methylphenol is also known as p-cresol. Effects associated with acute exposure to cresols in humans include irritation and burning of skin, eyes, mouth, and throat, abdominal pain and vomiting, hemolytic anemia, kidney damage, facial paralysis, coma, and death. Exposure levels associated with human deaths have not been reliably reported, however, crude estimates based on accidental or intentional ingestion of cresol, the lethal oral exposure level for humans appeared to be at or above 2 g/kg (Chan et al., 1971). Autopsies of people who died following cresol exposure revealed gross lesions in the lungs, pancreas, liver, and kidneys, although these data cannot be considered reliable indicators of target organ effects. Studies in animals have shown that cresols can be lethal when exposure is through the inhalation, oral, or dermal routes. 4-Methylphenol is classified "C" in USEPA's weight of evidence. An RfDo of 5.0E-03 has been issued for 4-methylphenol (USEPA 1996f).

Naphthalene cause hemolysis with subsequent blocking of renal tubules by precipitated hemoglobin. Hepatic necrosis has been reported. Hemolysis only occurs in individuals with a hereditary deficiency of glucose-6-phosphate dehydrogenase in the red cells (primarily black males), which results in a low level of reduced glutathione and increased susceptibility to hemolysis by metabolites of naphthalene. The fatal dose of ingested naphthalene is approximately 2 grams. These chemicals are most dangerous in children up to age 6, in whom absorption occurs rapidly. The exposure limit for naphthalene is 10 ppm (Dreisbach et al., 1987). The RfDo for naphthalene is 4E-02 mg/kg-day (USEPA ,1996f).

Toluene is a gasoline additive and is used as a solvent in glues, inks, adhesives, and is used as a detergent in the manufacture of dyes, lacquers, perfumes, pharmaceuticals, and saccharin. In humans, toluene is a known respiratory irritant with central nervous system effects, and the effects can be enhanced by the ingestion of ethyl alcohol. Toluene has not been determined to be a carcinogen by USEPA, having a USEPA Classification of D. As listed in IRIS, the basis for the classification is no human data and inadequate animal data. Toluene did not produce positive results in the majority of genotoxic assays. The critical effect of this volatile organic chemical is changes in liver and kidney weights in study organisms. USEPA determined the inhalation RfC and oral RfD to be 0.4 mg/m^3 and 0.01 mg/kg-day, respectively. As listed in IRIS, the oral RFD critical effect of this chemical is changes in liver and kidney weights. The uncertainty factor was determined to be 1,000 and the modifying factor was determined to be 1. The inhalation RFD critical effect of this chemical is neurological effects. The uncertainty factor was determined to be 300 and the modifying factor was determined to be 1. (Harte, et al., 1991) (IRIS).

Xylene is primarily a man-made chemical, which is a colorless liquid with a sweet odor. Chemical industries produce xylene from petroleum and to a smaller extent from coal. Xylene also occurs naturally in petroleum coal tar, and is formed during forest fires. Acute exposure data in humans and/or animals indicate that the CNS and possibly the developing fetus are the major targets of acute xylene toxicity by the inhalation and oral routes. Death has been observed to occur as a result of exposure by inhalation, oral and dermal exposure (Gosselin et al., 1984; Abu al Raghep et al., 1986; Bernardelli and Gennari, 1987). Acute studies have demonstrated that xylene is irritates the skin and eyes. Xylene inhalation has also been shown to irritate the respiratory tract and cause dyspnea. The central nervous system and the liver appear to be the primary; targets of chronic xylene exposure. USEPA has classified mixed xylene as a Group D agent (IRIS, 1993). Xylene (mixed) has been issued an RfDo of 2E+00 (IRIS, 1996).

10.5.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.5.18 and 10.5.19 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 609 surface soils is 3E-4. The dermal pathway ILCR is 3E-5. Arsenic was the primary contributor to ILCR

Table 10.5.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics							
Antimony	0.0004	NA	0.042	0.39	ND	0.015	ND
Arsenic	0.0003	1.5	0.52	4.8	2.7E-04	0.19	3.0E-05
Beryllium	0.005	4.3	0.00040	0.0037	9.8E-06	0.00014	1.1E-06
Manganese	0.047	NA	0.011	0.11	ND	0.0041	ND
Semivolatile Organics							
Benzo(a)pyrene Equivalen	NA	7.3	ND	ND	3.0E-06	ND	3.3E-07
SUM Hazard Index/ILCR			0.6	5	3E-04	0.2	3E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.5.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics								
Antimony	0.2	8E-05	NA	0.0086	0.0283	ND	0.0061	ND
Arsenic	0.2	6E-05	7.5	0.11	0.35	3.0E-05	0.076	1.2E-05
Beryllium	0.2	0.001	21.5	0.000081	0.00027	1.1E-06	0.000058	4.5E-07
Manganese	0.2	0.0094	NA	0.0023	0.0077	ND	0.0017	ND
Semivolatile Organics								
Benzo(a)pyrene Equivalen	0.5	NA	14.6	ND	ND	1.3E-06	ND	5.4E-07
SUM Hazard Index/ILCR				0.1	0.4	3E-05	0.08	1E-05

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

projections for the ingestion and dermal pathways, accounting for approximately 95% of the cumulative soil pathway risk. BEQs and beryllium were secondary contributors to both pathways. Risk estimates under a residential scenario are considered a highly conservative estimate of the risk due to recreational use.

The ingestion HIs projected for the adult and child receptors are 0.6 and 5, respectively. The dermal pathway HIs were 0.1 for the adult resident receptor and 0.4 for the child resident receptor. Arsenic was the primary contributor to hazard index projections for the dermal and ingestion pathways, accounting for approximately 90% of the cumulative hazard index. Antimony and manganese were secondary contributors to HI projections for the ingestion and dermal pathways. Hazard estimates under a residential scenario are considered a highly conservative estimate of the hazard index of the recreational scenario.

Hypothetical Site Workers

Site worker ILCRs are 3E-5 for the ingestion pathway and 1E-5 for the dermal contact pathway. Arsenic was the primary contributor to risk for both pathways, while BEQs were secondary contributors to the ingestion pathway.

Site worker HIs are 0.2 for the ingestion pathway and 0.08 for the dermal pathway.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under a residential scenario based on the results of the first quarter sampling event. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the surficial aquifer, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Tables 10.5.20 and 10.5.21 present the risk and hazard for the ingestion and inhalation pathways, respectively.

Hypothetical Site Residents

The projected ILCR for the future residential scenario is 2E-02 for the ingestion pathway and 1E-02 for the inhalation pathway. Benzene was the primary contributor to risk projections for both pathways, accounting for approximately 95% of the cumulative risk for the groundwater pathways. Arsenic was a secondary contributor to ILCR projections for the groundwater ingestion pathway.

The projected hazard indices for the adult and child resident are 21 and 50, respectively, for the ingestion pathway. Arsenic, 4-methylphenol, and toluene were primary contributors to the ingestion pathway, accounting for nearly 90% of the projected HI estimates. Aluminum, 2,4-dimethylphenol, 2-methylphenol, naphthalene, ethylbenzene, and xylene were secondary contributors to the ingestion pathway. The projected hazard indices for the adult and child resident are 558 and 1,303 for the inhalation pathway. Benzene was the primary contributor for the inhalation pathway, accounting for over 97% of the projected HI estimates. Toluene was also a significant contributor to HI projections for the inhalation pathway.

Hypothetical Site Workers

The projected groundwater ingestion pathway ILCR for the site worker scenario is 4E-03. Benzene was the primary contributor to both pathways, accounting for approximately 95% of the cumulative risk for the groundwater pathways. Arsenic was a secondary contributor to risk projections for the ingestion pathway.

Table 10.5.20
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
AOC 609
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics							
Aluminum (Al)	1	NA	0.21	0.50	ND	0.076	ND
Arsenic (As)	0.0003	1.5	6.0	14	1.5E-03	2.1	3.4E-04
Semivolatile Organics							
2,4-Dimethylphenol	0.02	NA	0.52	1.2	ND	0.19	ND
2-Methylphenol	0.05	NA	0.55	1.3	ND	0.20	ND
4-Methylphenol	0.005	NA	5.3	12	ND	1.9	ND
Naphthalene	0.04	NA	0.37	0.86	ND	0.13	ND
Volatile Organics							
Benzene	NA	0.029	ND	ND	1.5E-02	ND	3.4E-03
Chlorobenzene	0.02	NA	0.015	0.035	ND	0.0054	ND
Ethylbenzene	0.1	NA	0.66	1.5	ND	0.23	ND
Toluene	0.2	NA	7.7	18	ND	2.7	ND
Xylene (total)	2	NA	0.21	0.48	ND	0.073	ND
SUM Hazard Index/ILCR			21	50	2E-02	8	4E-03

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.5.21
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants in Groundwater Resulting from Domestic Use
AOC 607
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Inhalation Rf Used (mg/kg-day)	Inhalation SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Volatile Organics							
Benzene	0.00171	0.029	545	1271	1.5E-02	195	3.4E-03
Chlorobenzene	0.00571	NA	0.053	0.12	ND	0.019	ND
Ethylbenzene	0.268	NA	0.25	0.57	ND	0.088	ND
Toluene	0.114	NA	13	31	ND	4.8	ND
Xylene (total)	NA	NA	ND	ND	ND	ND	ND
SUM Hazard Index/ILCR			558	1303	1E-02	199	3E-03

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

The projected site worker HI for the groundwater ingestion pathway is 8. Arsenic, 4-methylphenol, and toluene were primary contributors to projected HIs for the groundwater ingestion pathway, and 2,4-dimethylphenol, 2-methylphenol, naphthalene, and ethylbenzene were secondary contributors to the ingestion pathway. The projected site worker HI for the inhalation pathway is 199. Benzene was the primary contributor to the inhalation pathway, accounting for approximately 98% of the projected pathway estimate.

Current Site Workers

Groundwater is not currently used as a source for potable or process water at AOC 609 or other areas of Zone F. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGOs development process. Table 10.5.22 presents the COCs identified for AOC 609 surface soil and groundwater.

Surface Soils

Future Site Residents

BEQs, arsenic, and beryllium were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections. Antimony, arsenic, and manganese were identified as COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

BEQs, arsenic, and beryllium were identified as soil pathway COCs based on their contribution to cumulative industrial ILCR projections.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion, residential soil RBCs and background concentrations were compared to each reported COC concentration. BEQs were detected in one of six surface soil exceeding its residential RBC (88 μg/kg). Arsenic was detected above its RBC (0.43 mg/kg) in all six surface soil samples; however, arsenic exceeded its background value (19.9 mg/kg) in one surface soil sample. Beryllium exceeded its RBC (0.15 mg/kg) in four of six surface soil samples. Beryllium exceeded its background value (1.05 mg/kg) in one surface soil sample. Antimony was detected in one of six surface soil samples exceeding its RBC (3.1 mg/kg). Manganese exceeded its RBC (180 mg/kg) in three of six surface soil samples, and exceeded its background value (307 mg/kg) in only one surface soil sample.

First Quarter Groundwater

Future Site Residents

Arsenic and benzene were identified as COCs based on their contribution to cumulative groundwater pathway risk projections. Aluminum, arsenic, benzene, chlorobenzene, 2,4-dimethylphenol, ethylbenzene, 2-methylphenol, 4-methylphenol, naphthalene, toluene, and xylene were identified as COCs based on their contribution to cumulative HI projections.

Table 10.5.22
Summary of Risk and Hazard-based COCs
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs			
Surface Soil	Incidental Ingestion	**Inorganics**									
		Antimony	0.042	0.39	ND	0.015	ND	1			
		Arsenic	0.52	4.8	2.7E-04	0.19	3.0E-05	1	2		4
		Beryllium	0.00040	0.0037	9.8E-06	0.00014	1.1E-06		2		4
		Manganese	0.011	0.11	ND	0.0041	ND	1			
		Semivolatile Organics									
		Benzo(a)pyrene Equivalents	ND	ND	3.0E-06	ND	3.3E-07		2		
	Dermal Contact	**Inorganics**									
		Antimony	0.0086	0.028	ND	0.0061	ND				
		Arsenic	0.11	0.35	3.0E-05	0.076	1.2E-05	1	2		4
		Beryllium	0.000081	0.00027	1.1E-06	0.000058	4.5E-07		2		
		Manganese	0.0023	0.0077	ND	0.0017	ND				
		Semivolatile Organics									
		Benzo(a)pyrene Equivalents	ND	ND	1.3E-06	ND	5.4E-07		2		
Surface Soil Pathway Sum			0.7	6	3E-04	0.3	4E-05				
Groundwater Pathways	Ingestion	**Inorganics**									
		Aluminum (Al)	0.21	0.50	ND	0.076	ND	1			
		Arsenic (As)	6.0	14	1.5E-03	2.1	3.4E-04	1	2	3	4
		Semivolatile Organics									
		2,4-Dimethylphenol	0.52	1.2	ND	0.19	ND	1		3	
		2-Methylphenol	0.55	1.3	ND	0.20	ND	1		3	
		4-Methylphenol	5.3	12.4	ND	1.9	ND	1		3	
		Naphthalene	0.37	0.86	ND	0.13	ND	1		3	
		Volatile Organics									
		Benzene	ND	ND	1.5E-02	ND	3.4E-03		2		4
		Chlorobenzene	0.015	0.035	ND	0.0054	ND				
		Ethylbenzene	0.66	1.5	ND	0.23	ND	1		3	
		Toluene	7.7	18	ND	2.7	ND	1		3	
		Xylene (total)	0.21	0.48	ND	0.073	ND	1			
	Inhalation	**Volatile Organics**									
		Benzene	545	1271	1.5E-02	195	3.4E-03	1	2	3	4
		Chlorobenzene	0.053	0.12	ND	0.019	ND	1			
		Ethylbenzene	0.25	0.57	ND	0.088	ND	1			
		Toluene	13	31	ND	5	ND	1		3	
		Xylene (total)	ND	ND	ND	ND	ND				
Groundwater Pathway Sum			580	1353	3E-02	207	7E-03				
Sum of All Pathways			581	1359	3E-02	207	7E-03				

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Future Site Workers

Arsenic and benzene were identified as COCs based on their contribution to cumulative risk projections. Arsenic, benzene, 2,4-dimethylphenol, ethylbenzene, 2-methylphenol, 4-methylphenol, naphthalene, and toluene were identified as COC based on their contribution to cumulative HI projections.

Arsenic exceeded its tap water RBC in all seven first quarter groundwater samples and exceeded its background concentration in four of seven first quarter groundwater samples. Aluminum was detected in two of seven first quarter groundwater samples at concentrations above its RBC. Except for chlorobenzene, all of the organic COCs detections (benzene, 2,4-dimethylphenol, ethylbenzene, 2-methylphenol, 4-methylphenol, naphthalene, toluene, and xylene) were reported in the first quarter groundwater sample collected from monitoring well SME005 only. Chlorobenzene was reported in the first quarter groundwater sample collected from monitoring well SME004.

10.5.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. If this area were to be used as a residential site, the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at AOC 609 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone F. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Since there were less than 10 surface soil and groundwater samples at AOC 609, the maximum reported concentrations of each COPC identified in groundwater were used as EPCs. For soil, inorganic constituents only exceeded their background concentrations in one surface soil sample each (609SB002 for antimony, arsenic, and beryllium; 609SB001 for manganese), on the northwest perimeter of the site, which makes it difficult to conclude if the extent of the inorganic constituents has been adequately defined. For groundwater, the only detections of organic COCs were reported in monitoring well SME005, at the southern perimeter of the site which makes it difficult to conclude whether the extent of organics in the groundwater has been adequately defined. However, currently available data suggests that use of maximum concentrations as EPCs would likely cause an overestimation of risk and hazard for this site.

Frequency of Detection and Spatial Distribution

BEQ compounds were detected in only one surface soil sample concentration above its RBC. Arsenic, antimony, beryllium, and manganese were each detected in only one surface soil sample above their respective background concentrations.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for AOC 609. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, only chromium was reported at a concentration near its RBC (e.g. within 10% of its RBC). Aluminum was detected at concentrations exceeding its RBC in five of six surface soil samples, however, its maximum concentration did not exceed its background concentration. As a result, aluminum was eliminated from consideration in the risk assessment.

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported close to its RBC (e.g. within 10% of its RBC). Manganese was detected in four of seven groundwater samples above its RBC, however, its maximum concentration did not exceed its shallow groundwater background concentration and was therefore eliminated from consideration from the risk assessment.

Groundwater is not currently used as a potable water source at AOC 609, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Subsequent groundwater sampling rounds generally produced lower reported concentrations of COCs than were reported in the first quarter. However, except for aluminum and chlorobenzene, reported concentrations of all COCs remained greater than RBCs.

Background-Related Risk

Soil

Aluminum was detected in AOC 609 surface soil above its RBC and manganese was detected in groundwater exceeding its RBC. These elements were eliminated from consideration in the risk assessment based on comparison to corresponding background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed RBCs. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations.

The maximum surface soil concentration of aluminum (16,650 mg/kg) for AOC 609 equals a hazard quotient of 0.2 for the residential child. The maximum concentration of manganese in groundwater (1,300 μg/L) for AOC 609 equals a hazard quotient of 4, however the background concentration of manganese (2,010 μg/L) equals a hazard quotient of 6.

10.5.6.7 Risk Summary

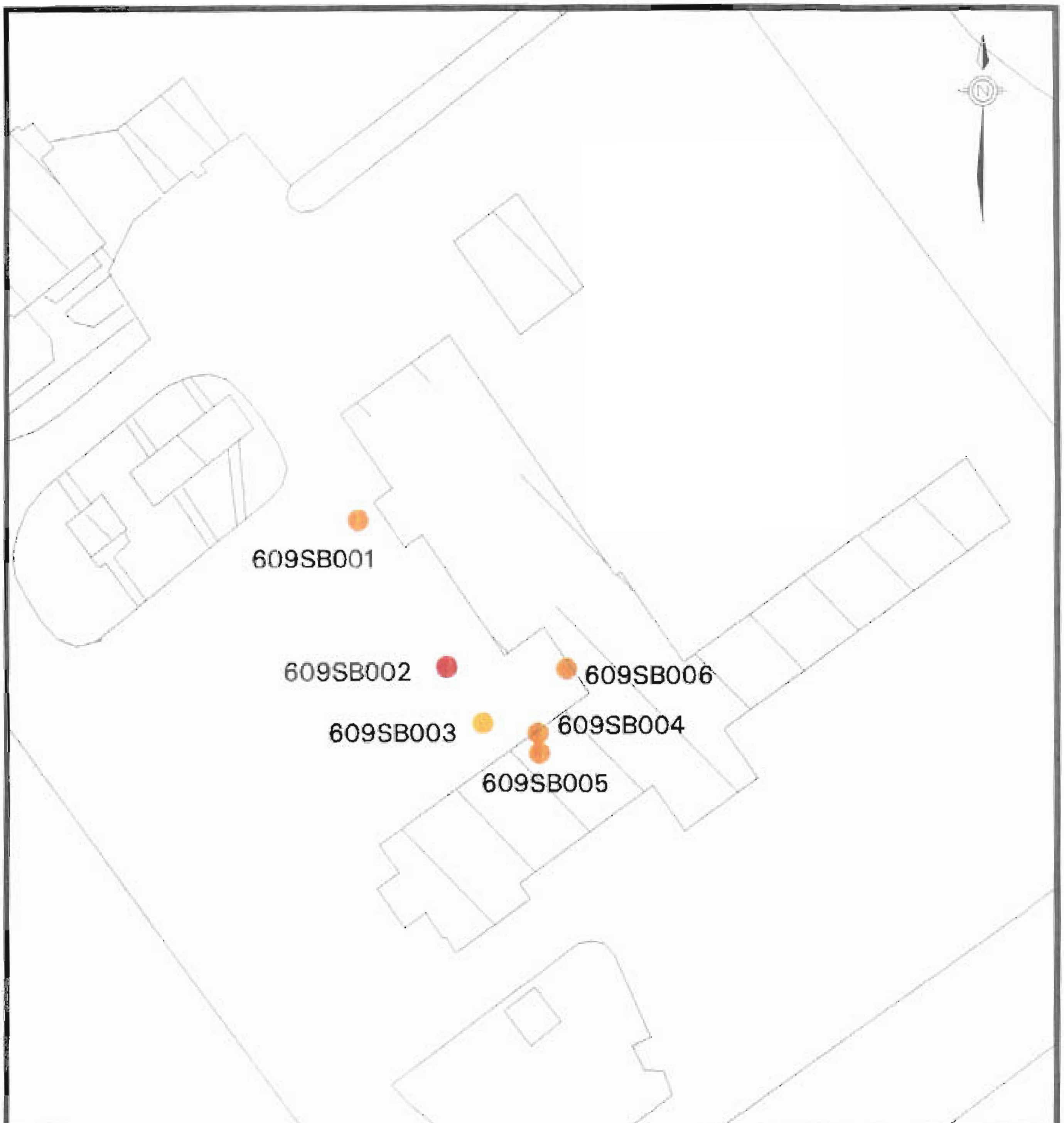
The risk and hazard posed by contaminants at AOC 609 were assessed for future site workers and future site residents under RME assumptions. For surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. For groundwater the ingestion and inhalation pathways were assessed. Table 10.5.23 presents the risk summary for each pathway/receptor group evaluated for AOC 609.

Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 609 are antimony, arsenic, BEQs, beryllium, and manganese. Figure 10.5-22 illustrates point risk estimates for AOC 609 based on soil exposure pathways under a future residential scenario. Table 10.5.24 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Arsenic and beryllium are the primary contributors to risk, accounting for 90% or more of the cumulative risk at each surface soil sample location. BEQs was a secondary contributor to risk estimates associated with one surface soil sample locations (609SB001). Risk estimates ranged from 8E-06 (609SB003) to 3E-04 (609SB002). The mean risk estimate is 7E-05.

Figure 10.5-23 illustrates point estimates for hazard at AOC 609 based on soil exposure pathways under a future residential scenario. Antimony and arsenic contributed to hazard estimates above unity at one surface soil location (609SB002). The rounded hazard index estimates ranged from 0.2 (609SB003) to 6 (609SB002). The mean hazard estimate is 1.



LEGEND
- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 100

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CHARLESTON, S.C.

FIGURE 10.5.22
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 609

Table 10.5.23
Summary of Risk and Hazard
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.6	5	3E-04	0.2	3E-05
	Dermal Contact	0.118	0.39	3E-05	0.084	1E-05
Groundwater	Ingestion	21	50	2E-02	8	4E-03
	Inhalation of VOCs	558	1303	1E-02	199	3E-03
Sum of All Pathways		581	1359	3E-02	207	7E-03

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

Table 10.5.24
Point Estimates of Risk and Hazard - Soil Pathways
Residential Scenario
AOC 609
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	%HI	Risk (E-06)	% Risk
609	001	Antimony (Sb)	ND	MG/KG	NA		NA	
609	001	Arsenic (As)	14.5	MG/KG	0.6628	84.99	37.8740	76.96
609	001	B(a)P Equiv.	261.88	UG/KG	NA		4.3368	8.81
609	001	Beryllium (Be)	0.935	MG/KG	0.0026	0.33	7.0010	14.23
609	001	Manganese (Mn)	392.5	MG/KG	0.1145	14.68	NA	
		Total			0.7798		49.2119	
609	002	Antimony (Sb)	12.2	MG/KG	0.4182	7.32	NA	
609	002	Arsenic (As)	113.8	MG/KG	5.2015	91.05	297.2457	96.25
609	002	B(a)P Equiv.	44.0515	UG/KG	NA		0.7295	0.24
609	002	Beryllium (Be)	1.45	MG/KG	0.0040	0.07	10.8572	3.52
609	002	Manganese (Mn)	305	MG/KG	0.0890	1.56	NA	
		Total			5.7127		308.8324	
609	003	Antimony (Sb)	ND	MG/KG	NA		NA	
609	003	Arsenic (As)	2.9	MG/KG	0.1326	75.62	7.5748	100.00
609	003	B(a)P Equiv.	ND	UG/KG	NA		NA	
609	003	Beryllium (Be)	ND	MG/KG	NA		NA	
609	003	Manganese (Mn)	146.5	MG/KG	0.0427	24.38	NA	
		Total			0.1753		7.5748	
609	004	Antimony (Sb)	ND	MG/KG	NA		NA	
609	004	Arsenic (As)	7.2	MG/KG	0.3291	85.82	18.8064	78.49
609	004	B(a)P Equiv.	49	UG/KG	NA		0.8115	3.39
609	004	Beryllium (Be)	0.58	MG/KG	0.0016	0.41	4.3429	18.13
609	004	Manganese (Mn)	181	MG/KG	0.0528	13.77	NA	
		Total			0.3835		23.9607	
609	005	Antimony (Sb)	ND	MG/KG	NA		NA	
609	005	Arsenic (As)	7.4	MG/KG	0.3382	94.63	19.3288	100.00
609	005	B(a)P Equiv.	ND	UG/KG	NA		NA	
609	005	Beryllium (Be)	ND	MG/KG	NA		NA	
609	005	Manganese (Mn)	65.8	MG/KG	0.0192	5.37	NA	
		Total			0.3574		19.3288	
609	006	Antimony (Sb)	ND	MG/KG	NA		NA	
609	006	Arsenic (As)	8.6	MG/KG	0.3931	90.60	22.4632	80.65
609	006	B(a)P Equiv.	ND	UG/KG	NA		NA	
609	006	Beryllium (Be)	0.72	MG/KG	0.0020	0.46	5.3912	19.35
609	006	Manganese (Mn)	133	MG/KG	0.0388	8.94	NA	
		Total			0.4339		27.8544	

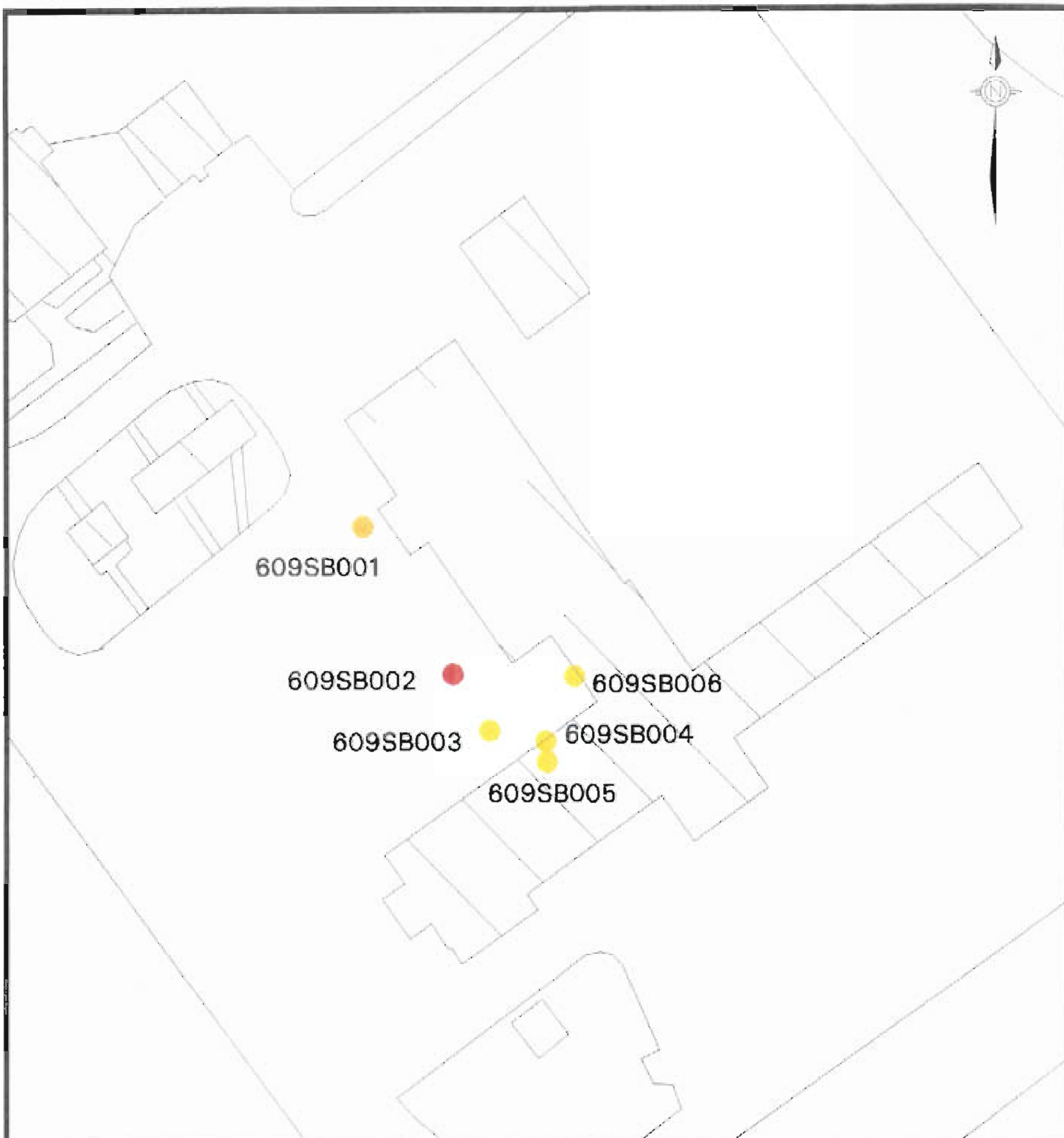
Soil — Site Worker Scenario

Industrial soil pathway COCs identified for AOC 609 were arsenic and beryllium. Figure 10.5-24 illustrates point risk estimates for AOC 609 based on soil exposure pathways under a future industrial scenario. Table 10.5.25 summarizes the risk and hazard contribution of each COC at each sample location. Arsenic was the primary contributor to risk estimates above 1E-06 for the industrial scenario at AOC 609, and beryllium was a secondary contributor. Risk estimates ranged from 1E-06 (609SB003) to 4E-05 (609SB002). The mean risk estimate is 1E-05.

The rounded hazard index estimates ranged from 0.007 (609SB003) to 0.3 (609SB002).

Groundwater — Residential Scenario

Aluminum, arsenic, benzene, chlorobenzene, 2,4-dichlorophenol, ethylbenzene, 2-methylphenol, 4-methylphenol, naphthalene, toluene, and xylene were identified as groundwater pathway COCs. Figures 10.5-25 and 10.5-26 illustrates point risk and hazard estimates for AOC 609 based on groundwater exposure pathways under a future residential scenario. As shown in Table 10.5.26, arsenic was the sole contributor to ILCR and HI projections at all locations except for monitoring well SME005. Benzene was the most significant contributor to risk and hazard estimates associated with the groundwater sample collected from SME005. Ethylbenzene, toluene, 2,4-dimethylphenol, 2-methylphenol, and 4-methylphenol were all secondary contributors to hazard projections at location SME005. Risk estimates ranged from 1E-04 (SME007) to 3E-02 (SME005) with a mean risk of 5E-03. Hazard estimates ranged from 1 (SME003) to 2619 (SME005) with a mean hazard of 441.



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 100

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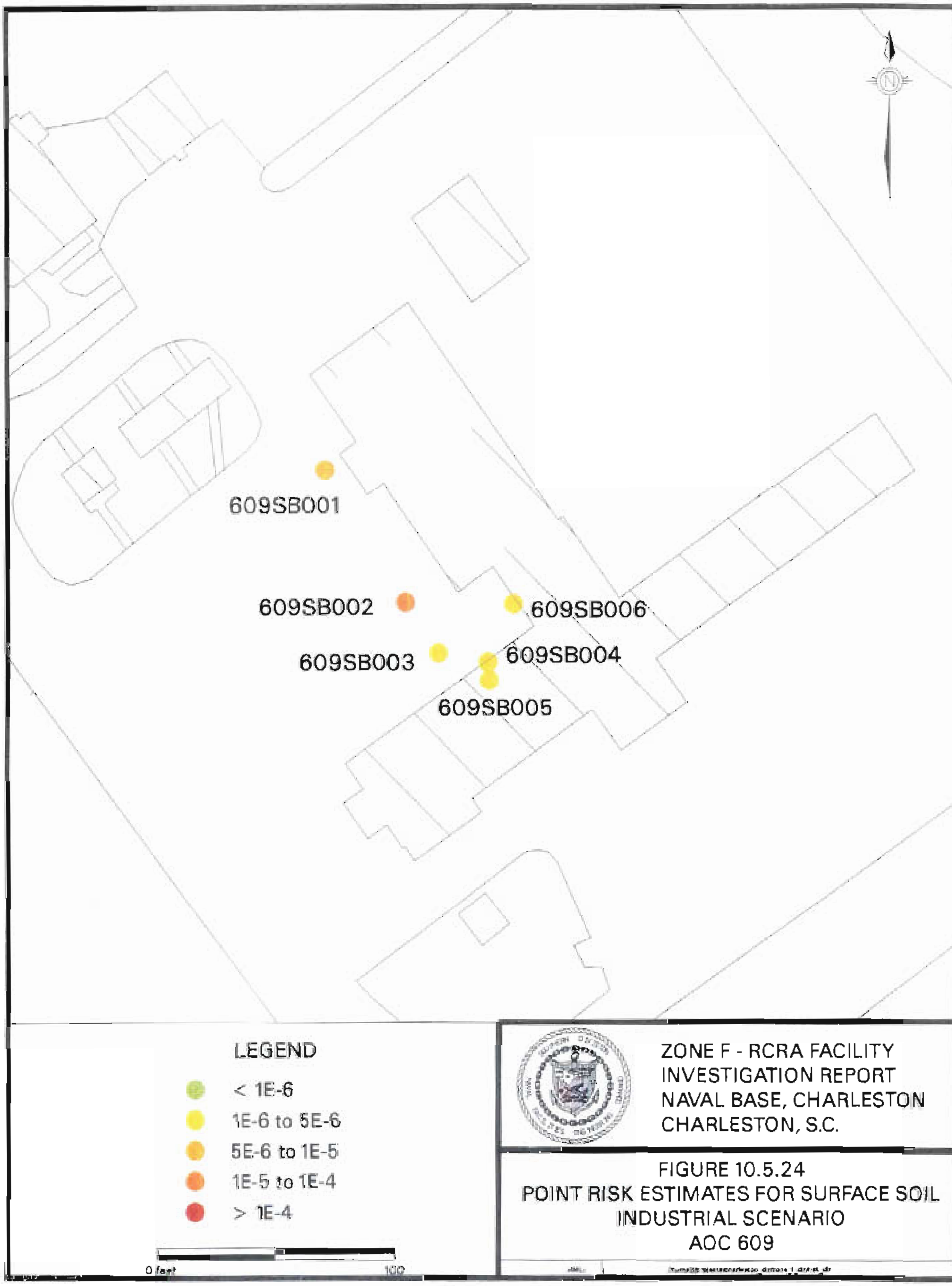
FIGURE 10.5.23
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 609



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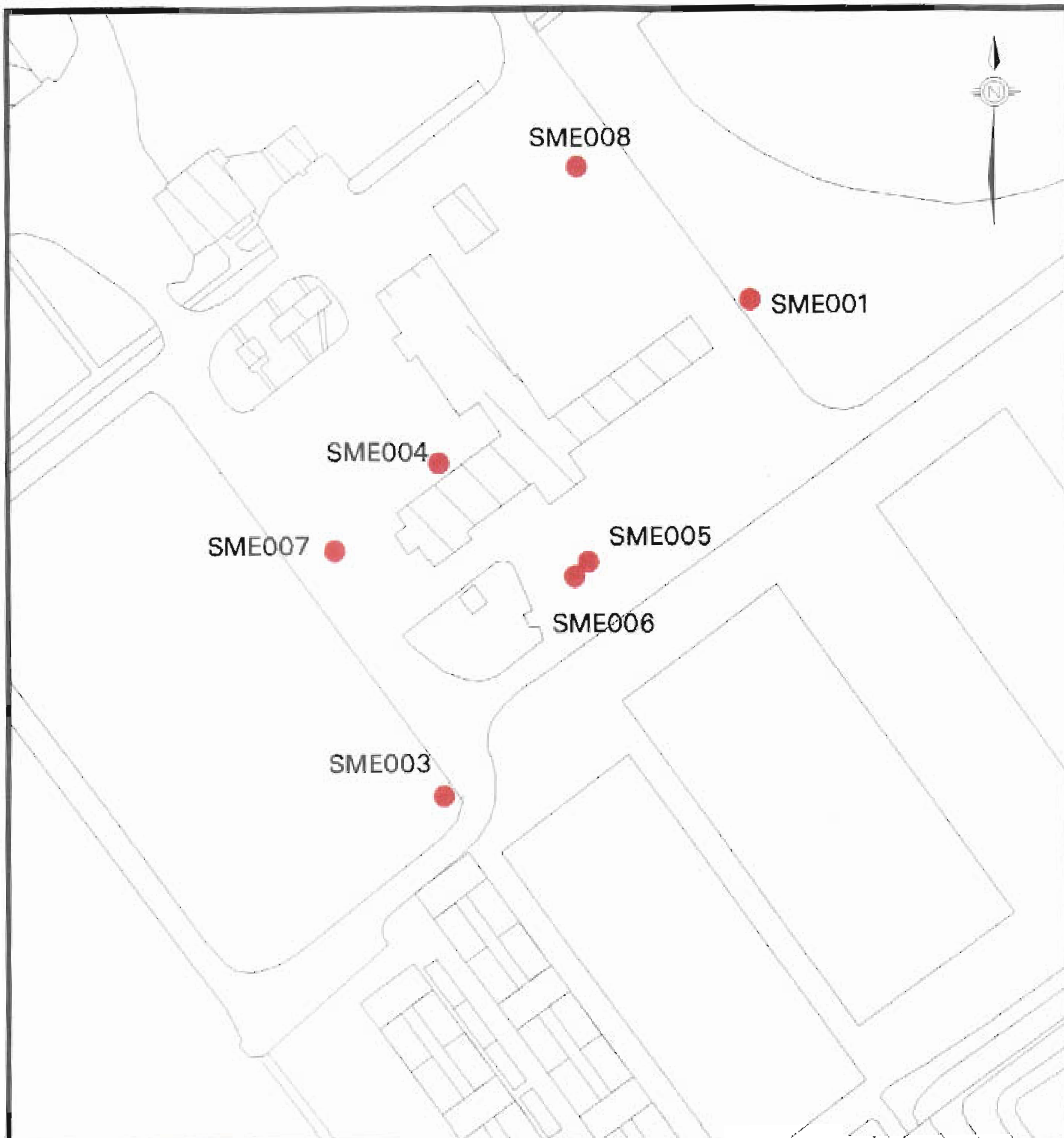
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5.24
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
AOC 609



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 200

ZONE F - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
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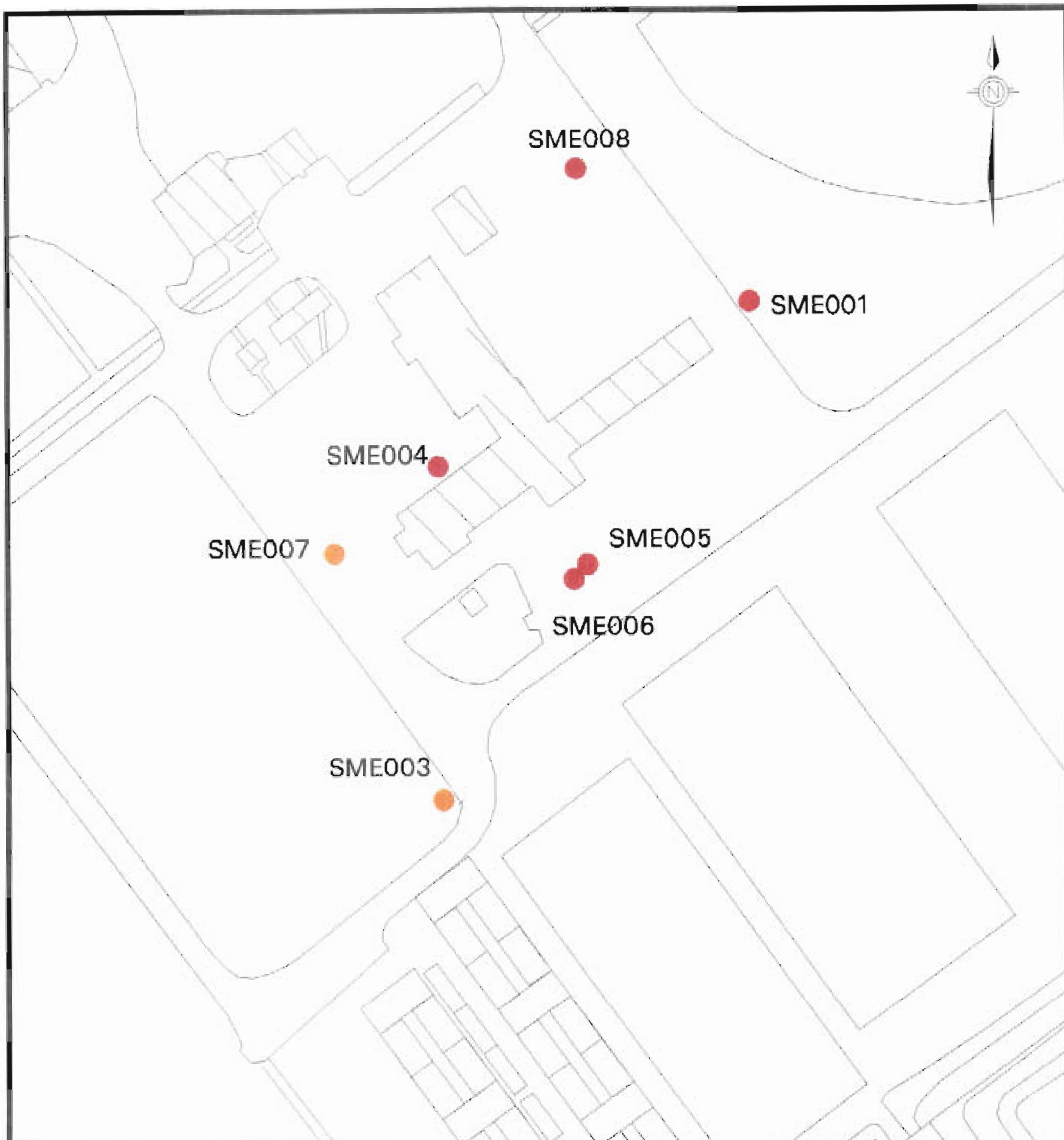
FIGURE 10.5.25
POINT RISK ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 609



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 200

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FIGURE 10.5.26
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 609

Table 10.5.25
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 609
NABASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
609	001	Arsenic (As)	14.5	MG/KG	0.0333	99.61	5.3579	84.40
609	001	Beryllium (Be)	0.935	MG/KG	0.00013	0.39	0.9904	15.60
		Total			0.03347		6.3483	
609	002	Arsenic (As)	113.8	MG/KG	0.2617	99.92	42.0499	96.48
609	002	Beryllium (Be)	1.45	MG/KG	0.00020	0.08	1.5359	
		Total			0.26186		43.5858	
609	003	Arsenic (As)	2.9	MG/KG	0.0067	100.00	1.0716	16.88
609	003	Beryllium (Be)	ND	MG/KG	NA		NA	
		Total			0.00667		1.0716	
609	004	Arsenic (As)	7.2	MG/KG	0.0166	99.52	2.6605	81.24
609	004	Beryllium (Be)	0.58	MG/KG	0.000080	0.48	0.6144	18.76
		Total			0.01663		3.2748	
609	005	Arsenic (As)	7.4	MG/KG	0.0170	100.00	2.7344	100.00
609	005	Beryllium (Be)	ND	MG/KG	NA		NA	
		Total			0.01701		2.7344	
609	006	Arsenic (As)	8.6	MG/KG	0.0198	99.50	3.1778	80.65
609	006	Beryllium (Be)	0.72	MG/KG	0.00010	0.50	0.7627	19.35
		Total			0.01987		3.9404	

Table 10.5.26
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 609
NAVBASE - Charleston
Charleston, South Carolina

Location		Parameter	Concentration	Units	Hazard Quotient	% HI	Risk (E-06)	
SME	001	2,4-Dimethylphenol	ND	UG/L	NA		NA	
SME	001	2-Methylphenol (o-Cresol)	ND	UG/L	NA		NA	
SME	001	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
SME	001	Aluminum (Al)	4450	UG/L	0.2845	2.01	NA	
SME	001	Arsenic (As)	65.2	UG/L	13.8935	97.99	1454.5597	100.00
SME	001	Benzene	ND	UG/L	NA		NA	
SME	001	Chlorobenzene	ND	UG/L	NA		NA	
SME	001	Ethylbenzene	ND	UG/L	NA		NA	
SME	001	Naphthalene	ND	UG/L	NA		NA	
SME	001	Toluene	ND	UG/L	NA		NA	
SME	001	Xylene (Total)	ND	UG/L	NA		NA	
		Total			14.1779		1454.5597	
SME	003	2,4-Dimethylphenol	ND	UG/L	NA		NA	
SME	003	2-Methylphenol (o-Cresol)	ND	UG/L	NA		NA	
SME	003	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
SME	003	Aluminum (Al)	127	UG/L	0.0081	0.58	NA	
SME	003	Arsenic (As)	6.5	UG/L	1.3851	99.42	145.0098	100.00
SME	003	Benzene	ND	UG/L	NA		NA	
SME	003	Chlorobenzene	ND	UG/L	NA		NA	
SME	003	Ethylbenzene	ND	UG/L	NA		NA	
SME	003	Naphthalene	ND	UG/L	NA		NA	
SME	003	Toluene	ND	UG/L	NA		NA	
SME	003	Xylene (Total)	ND	UG/L	NA		NA	
		Total			1.3932		145.0098	
SME	004	2,4-Dimethylphenol	ND	UG/L	NA		NA	
SME	004	2-Methylphenol (o-Cresol)	ND	UG/L	NA		NA	
SME	004	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
SME	004	Aluminum (Al)	116	UG/L	0.0074	0.21	NA	
SME	004	Arsenic (As)	15.9	UG/L	3.3881	95.34	354.7162	100.00
SME	004	Benzene	ND	UG/L	NA		NA	
SME	004	Chlorobenzene	11	UG/L	0.1583	4.45	NA	
SME	004	Ethylbenzene	ND	UG/L	NA		NA	
SME	004	Naphthalene	ND	UG/L	NA		NA	
SME	004	Toluene	ND	UG/L	NA		NA	
SME	004	Xylene (Total)	ND	UG/L	NA		NA	
		Total			3.5539		354.7162	
SME	005	2,4-Dimethylphenol	380	UG/L	1.2146	0.05	NA	
SME	005	2-Methylphenol (o-Cresol)	1000	UG/L	1.2785	0.05	NA	
SME	005	4-Methylphenol (p-Cresol)	970	UG/L	12.4018	0.47	NA	
SME	005	Aluminum (Al)	458	UG/L	0.0293	0.001	NA	
SME	005	Arsenic (As)	41.6	UG/L	8.8645	0.34	928.0626	3.07
SME	005	Benzene	34000	UG/L	2542.1240	97.06	29329.1586	96.93
SME	005	Chlorobenzene	ND	UG/L	NA		NA	
SME	005	Ethylbenzene	2400	UG/L	2.0707	0.08	NA	
SME	005	Naphthalene	540	UG/L	0.8630	0.03	NA	
SME	005	Toluene	56000	UG/L	49.3022	1.88	NA	
SME	005	Xylene (Total)	15000	UG/L	0.9589	0.04	NA	
		Total			2619.1076		30257.2213	
SME	007	2,4-Dimethylphenol	ND	UG/L	NA		NA	
SME	007	2-Methylphenol (o-Cresol)	ND	UG/L	NA		NA	
SME	007	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
SME	007	Aluminum (Al)	7745	UG/L	0.4951	30.88	NA	
SME	007	Arsenic (As)	5.2	UG/L	1.1081	69.12	116.0078	100.00
SME	007	Benzene	ND	UG/L	NA		NA	
SME	007	Chlorobenzene	ND	UG/L	NA		NA	
SME	007	Ethylbenzene	ND	UG/L	NA		NA	
SME	007	Naphthalene	ND	UG/L	NA		NA	
SME	007	Toluene	ND	UG/L	NA		NA	
SME	007	Xylene (Total)	ND	UG/L	NA		NA	
		Total			1.6032		116.0078	

SME	008	2,4-Dimethylphenol	ND	UG/L	NA		NA	
SME	008	2-Methylphenol (o-Cresol)	ND	UG/L	NA		NA	
SME	008	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
SME	008	Aluminum (Al)	142	UG/L	0.0091	0.23	NA	
SME	008	Arsenic (As)	18.4	UG/L	3.9209	99.77	410.4892	100.00
SME	008	Benzene	ND	UG/L	NA		NA	
SME	008	Chlorobenzene	ND	UG/L	NA		NA	
SME	008	Ethylbenzene	ND	UG/L	NA		NA	
SME	008	Naphthalene	ND	UG/L	NA		NA	
SME	008	Toluene	ND	UG/L	NA		NA	
SME	008	Xylene (Total)	ND	UG/L	NA		NA	
		Total			3.9299		410.4892	

10.5.6.8 RGOs

Soil

Risk-based RGOs were based on the lifetime weighted average site resident or site worker as presented in Table 10.5.27 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.

Groundwater

Groundwater risk and hazard based RGOs for the site resident and site worker scenarios are shown in Table 10.5.28.

10.5.7 Corrective Measures Considerations

For AOC 609, the upper and lower soil intervals and shallow groundwater were investigated. A total of six soil samples each were collected from the upper and lower intervals. Seven groundwater monitoring wells previously installed in the shallow aquifer were sampled. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is mostly paved with asphalt or concrete.

BEQs, antimony, arsenic, beryllium, and manganese were identified as COCs in the upper soil interval. The soil pathway cumulative residential exposure risk is 3E-04 and the cumulative HI is 6 (resident child). The cumulative residential exposure risk is above USEPA's acceptable lowest risk level of 1E-04 and the HI is above USEPA's acceptable HI of 3 (Table 10.5.22).

Table 10.5.27
Remedial Goal Options Surface Soil
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Antimony	NA	0.0004	12.2	88	29	2.9	ND	ND	ND	0.79
Arsenic	1.5	0.0003	113.8	66	22	2.2	0.38	3.8	38	19.9
Beryllium	4.3	0.005	1.45	1094	365	36	0.13	1.3	13	1.05
Manganese	NA	0.047	392.5	10283	3428	343	ND	ND	ND	307
Semivolatile Organics										
Benzo(a)pyrene Equivalent	7.3	NA	0.26	ND	ND	ND	0.060	0.60	6.0	NA

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Arsenic	1.5	0.0003	113.8	1305	435	43	2.7	27	271	19.9
Beryllium	4.3	0.005	1.5	21745	7248	725	0.94	9.4	94	1.05

NOTES:

EPC Exposure point concentration
NA Not applicable
ND Not determined

- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.5.28
Remedial Goal Options Groundwater
AOC 609
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	Background Concentratio mg/l	MCL mg/l
Inorganics											
Aluminum (Al)	NA	1	7.745	1.6	16	47	ND	ND	ND	0.224	NA
Arsenic (As)	1.5	0.0003	0.0652	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.167	0.05
Semivolatile Organics											
2,4-Dimethylphenol	NA	0.02	0.38	0.031	0.31	0.94	ND	ND	ND	NA	NA
2-Methylphenol	NA	0.05	1	0.078	0.78	2.3	ND	ND	ND	NA	NA
4-Methylphenol	NA	0.005	0.97	0.0078	0.078	0.23	ND	ND	ND	NA	NA
Naphthalene	NA	0.04	0.54	0.063	0.63	1.9	ND	ND	ND	NA	NA
Volatile Organics											
Benzene	0.029	NA	34	0.0027	0.027	0.08	0.0011	0.011	0.11	NA	0.005
Chlorobenzene	NA	0.02	0.011	0.0069	0.069	0.21	ND	ND	ND	NA	NA
Ethylbenzene	NA	0.1	2.4	0.11	1.1	3.4	ND	ND	ND	NA	0.7
Toluene	NA	0.2	56	0.11	1.1	3.4	ND	ND	ND	NA	1
Xylene (total)	NA	2	15	3.1	31	94	ND	ND	ND	NA	10

Worker-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Inorganics											
Arsenic (As)	1.5	0.0003	0.0652	0.0031	0.031	0.092	0.00019	0.0019	0.019	0.167	0.05
Semivolatile Organics											
2,4-Dimethylphenol	NA	0.02	0.38	0.20	2.0	6.1	ND	ND	ND	NA	NA
2-Methylphenol	NA	0.05	1	0.51	5.1	15	ND	ND	ND	NA	NA
4-Methylphenol	NA	0.005	0.97	0.051	0.51	1.5	ND	ND	ND	NA	NA
Naphthalene	NA	0.04	0.54	0.41	4.1	12	ND	ND	ND	NA	NA
Volatile Organics											
Benzene	0.029	NA	34	0.0027	0.027	0.080	0.0049	0.049	0.49	NA	0.005
Chlorobenzene	NA	0.02	0.011	0.0069	0.069	0.21	ND	ND	ND	NA	NA
Ethylbenzene	NA	0.1	2.4	0.11	1.1	3.4	ND	ND	ND	NA	0.7
Toluene	NA	0.2	56	0.11	1.1	3.4	ND	ND	ND	NA	1
Xylene (total)	NA	2	15	3.1	31	94	ND	ND	ND	NA	10

NOTES:

EPC Exposure point concentration
NA Not applicable
ND Not determined
\- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Residential risk-based RGOs applicable to surface soil for arsenic, beryllium and BEQs are 0.38, 0.13, and 0.06 mg/kg, respectively, based on a target risk of 1E-06. Hazard-based RGOs for surface soil for antimony and manganese are 29 and 3,428 mg/kg, respectively, based on a target HI of 1. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.5.29.

Aluminum, arsenic, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, naphthalene, benzene, chlorobenzene, ethylbenzene, toluene, and xylene (total) were identified as residential groundwater COCs in the shallow groundwater at AOC 609. Arsenic and benzene have a calculated risk of 3E-02 associated with the present concentrations in the shallow groundwater at SME005. This risk is above USEPA's acceptable risk of 1E-04 (Table 10.5.22).

Table 10.5.29
Potential Corrective Measures for AOC 609

Medium	Compounds of Concern	Potential Corrective Measures
Soil	Antimony, arsenic, beryllium, manganese, and BEQs	a) No Action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment f) Ex-situ, chemical and physical treatment
Shallow Groundwater	Aluminum, arsenic, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, naphthalene, benzene, chlorobenzene, ethylbenzene, toluene, and xylene	a) No Action b) Intrinsic remediation and monitoring c) In-situ, biological, chemical and physical treatment d) Ex-situ, biological, chemical and physical treatment

Aluminum, arsenic, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, naphthalene, benzene, chlorobenzene, ethylbenzene, toluene, and xylene (total) have a calculated HI of 1,353 associated with their present concentrations. This HI is above USEPA's acceptable HI of 1. The risk-based RGOs for arsenic and benzene are 0.000044 and 0.0011 mg/L, respectively, based on a target of 1E-06. The hazard-based RGOs for aluminum, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, naphthalene, chlorobenzene, ethylbenzene, toluene, and xylene (total) are 16, 0.31, 0.78, 0.078, 0.63, 0.069, 1.1, 1.1, and 31 mg/L, respectively, based on a target HI of 1 (Table 10.5.22).

Potential corrective measures for the shallow groundwater and respective COCs are presented in Table 10.5.29. Corrective measures for AOC 609 are detailed in Section 9.

10.6 AOC 611, Grease Rack and Hobby Shop, Former Building 1264

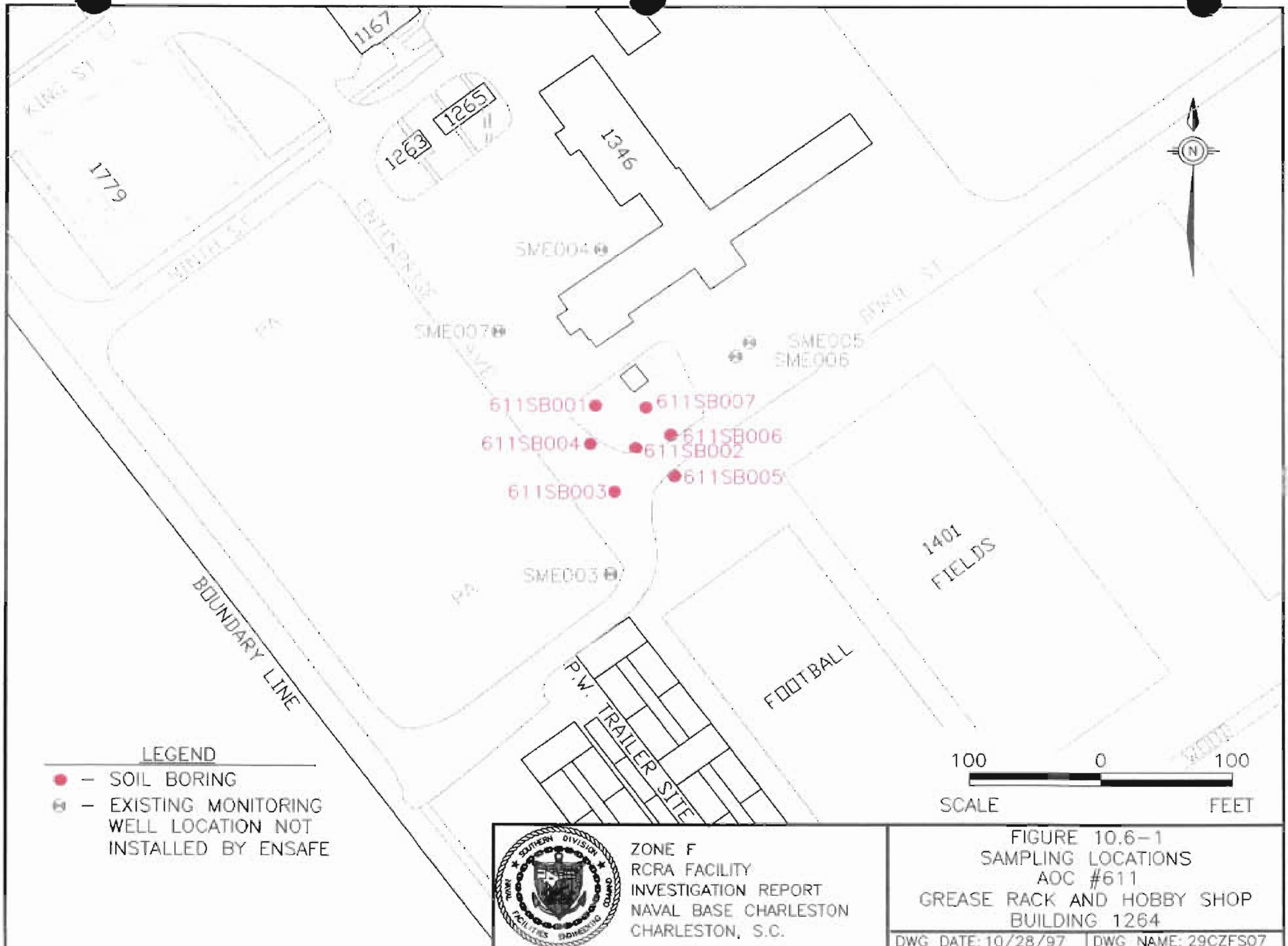
A CSI site, AOC 611 is the site is the former Building 1264, a small garage size structure which was used as an automotive hobby shop from the late 1950s to the early 1960s. The building has since been demolished and the site incorporated into a partially asphalt paved and grass covered area. Materials potentially released, stored, or disposed of at the site include petroleum products, antifreeze, isopropyl alcohol, solvents, degreasers, enamel paint, paint thinner, battery acid, and lead.

10.6.1 Site Geology

Figure 10.6-1 shows the soil sampling locations associated with the AOC 611 investigation. No monitoring wells were installed at AOC 611. Subsurface stratigraphic information from adjacent AOC 609 is quite similar. The subsurface stratigraphy should consist of approximately two-feet of silty sand overlying silty clay. Previously provided Figures 10.5-2 and 10.5-3 depict the shallow groundwater flow pattern in the AOC 611/609 area.

10.6.2 Field Investigation Approach

The objective of the field investigation at AOC 611 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Soil was the medium sampled during the field investigation. Section 3 of this report details the methods used during the field investigation. This section describes the hand-auger procedures used for soil sampling; the analytical protocols for sample analyses; and describes miscellaneous field procedures.



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-1
SAMPLING LOCATIONS
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 10/28/97 | DWG NAME: 29CZFS07

10.6.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing four soil borings within the AOC 611 area to assess the presence of any soil contamination at this site. Upper and lower interval soil samples were proposed from each boring. Based on the results of the four initial soil samples, three additional soil borings were advanced during the second-round of the field investigation. Upper and lower interval samples were collected from all seven soil borings. In accordance with the approved final RFI work plan, the four first-round soil samples were analyzed for metals, SVOAs, and VOAs at DQO Level III, and pH. Second-round samples were analyzed for metals and SVOAs only at DQO Level III. In addition, one second-round upper interval duplicate soil sample was collected for Appendix IX analyses at DQO Level IV. Table 10.6.1 summarizes the AOC 611 soil samples and analyses.

10.6.3.1 Nature of Contamination in Soil

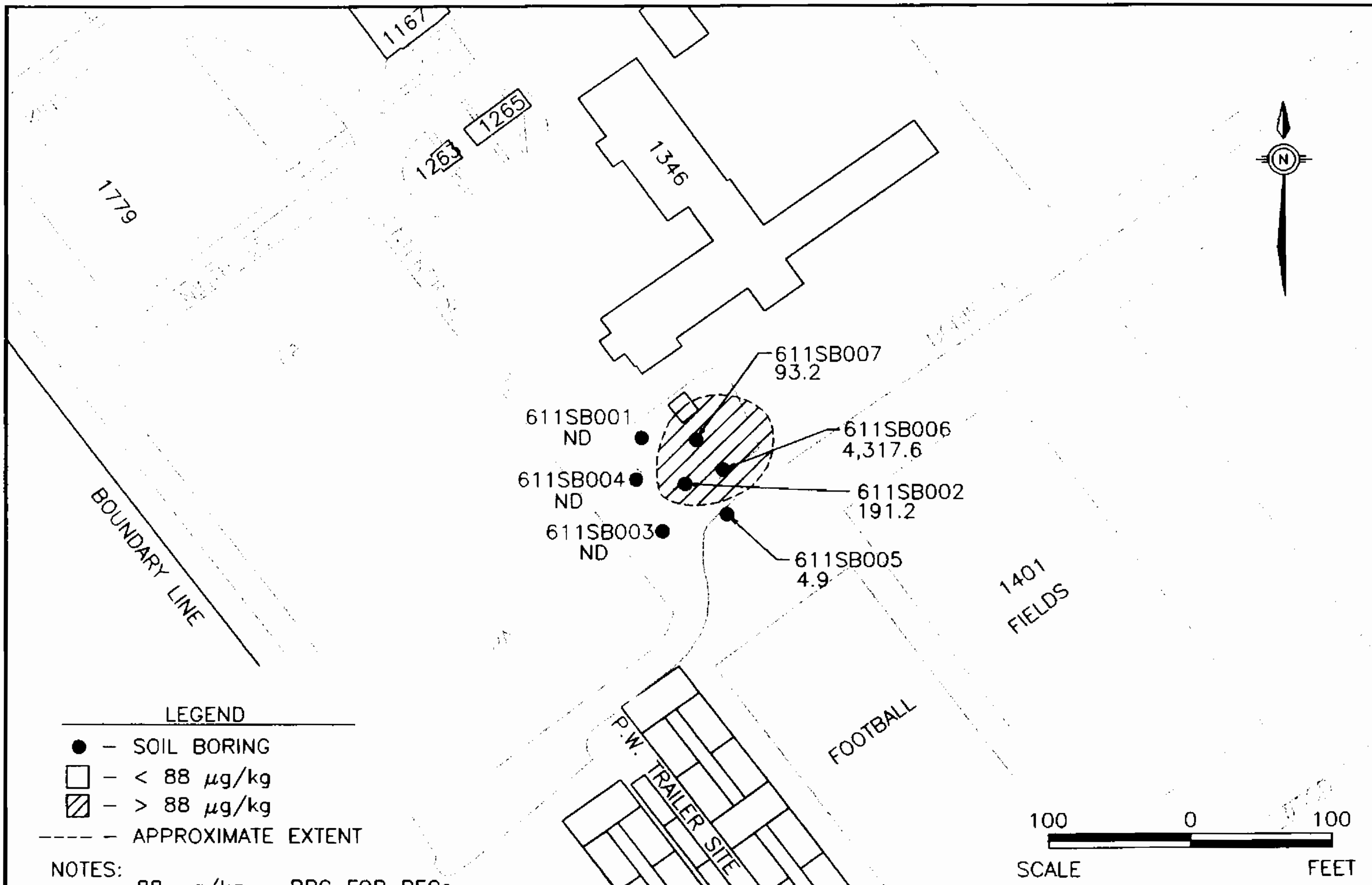
Organic compound analytical results for soil are summarized in Table 10.6.2. Inorganic analytical results for soil are summarized in Table 10.6.3. Table 10.6.4 presents a summary of all analytes detected in soil at AOC 611. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organic Compounds in Soil

No VOCs were detected above their respective RBCs in surface soil samples, or above their respective SSLs in subsurface soil at AOC 611.

Semivolatile Organic Compounds in Soil

Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected above their respective RBCs in surface soil samples at AOC 611. Figure 10.6-2 illustrates the distribution of these compounds as total BEQ concentrations in surface soil. No SVOC were detected in subsurface soil above their exceeding the SSL at AOC 611.



NOTES:
- 88 μg/kg = RBC FOR BEQs IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6–2
BEQs IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906SBEQ

Table 10.6.1
AOC 611
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
611SB001	611SB00101	Upper	9/24/96	Note 1	
	611SB00102	Lower			
611SB002	611SB00201	Upper	9/24/96	Note 1	
	611SB00202	Lower			
611SB003	611SB00301	Upper	9/24/96	Note1	
	611SB00302	Lower			
611SB004	611SB00401	Upper	9/24/96	Note 1	
	611SB00402	Lower			
611SB005	611SB00501	Upper	1/09/97	Note 2	Second-round sample
	611SB00502	Lower			
611SB006	611SB00601	Upper	1/09/97	Note 2	Second-round sample
	611SB00602	Lower			
611SB007	611SB00701	Upper	1/09/97	Notes 2/3	Second-round sample
	611CB00701*				*Duplicate sample
	611SB00702	Lower			

Notes:
1 = SW-846 (metals, SVOAs, and VOAs) at DQO Level III; pH.
2 = SW-846 (metals and SVOAs) at DQO Level III.
3 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV.
* = Duplicate sample

Table 10.6.2
AOC 611
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval – 4 Samples plus 1 Duplicate Sample/Lower Interval –4 Samples) (μg/kg)						
Carbon disulfide	Upper	0/5	ND	ND	780000	0
	Lower	1/4	2.0	2.0	32000[a]	0
Ethylbenzene	Upper	1/5	16.0	16.0	780000	0
	Lower	1/4	11.0	11.0	13000	0
Toluene	Upper	1/5	3.0	3.0	1600000	0
	Lower	0/4	ND	ND	12000	0
Xylene (total)	Upper	2/5	2.0 - 100.0	51.0	16000000	0
	Lower	1/4	50.0	50.0	142000	0
Semivolatile Organic Compounds (Upper Interval – 7 Samples plus 1 Duplicate Sample/Lower Interval –7 Samples) (μg/kg)						
BEQs[1]	Upper	4/7	4.9 - 4317.6	1151.72	88.0	3
	Lower	0/0	NA	NA	NA	NA
2-Methylnaphthalene	Upper	1/7	88.5	88.5	310000	0
	Lower	2/7	130.0 - 12000	6065.0	126000	0
Acenaphthene	Upper	1/7	160.0	160.0	470000	0
	Lower	0/7	ND	ND	570000[a]	0
Acenaphthylene	Upper	2/7	50.5 - 720.0	385.25	310000	0
	Lower	0/7	ND	ND	293000	0
Anthracene	Upper	3/7	44.5 - 540.0	212.83	2300000	0
	Lower	1/7	110.0	110.0	12000000[a]	0

Table 10.6.2
AOC 611
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (Upper Interval – 7 Samples plus 1 Duplicate Sample/Lower Interval – 7 Samples) (μg/kg)						
Benzo(a)anthracene	Upper	3/7	57.5 - 1900.0	683.17	880	1
	Lower	1/7	53.0	53.0	2000[b]	0
Benzo(a)pyrene	Upper	3/7	70.0 - 3000.0	1060.0	88	2
	Lower	0/7	ND	ND	8000	0
Benzo(b)fluoranthene	Upper	3/7	49.0 - 3500.0	1210.83	880	1
	Lower	0/7	ND	ND	5000[b]	0
Benzo(g,h,i)perylene	Upper	4/7	44.0 - 1400.0	433.5	230000	0
	Lower	0/7	ND	ND	4.66E+08	0
Benzo(k)fluoranthene	Upper	3/7	85.5 - 3400.0	1221.83	8800	0
	Lower	0/7	ND	ND	49000[b]	0
Benzoic acid	Upper	2/7	61.0 - 110.0	85.5	31000000	0
	Lower	0/7	ND	ND	400000[a,d]	0
Chrysene	Upper	4/7	45.0 - 3600.0	971.5	88000	0
	Lower	1/7	51.0	51.0	160000[b]	0
Di-n-butylphthalate	Upper	1/7	65.0	65.0	780000	0
	Lower	0/7	ND	ND	2300000[c]	0
Di-n-octylphthalate	Upper	2/7	54.0 - 240.0	147.0	160000	0
	Lower	0/7	ND	ND	10000000[c]	0
Dibenz(a,h)anthracene	Upper	2/7	58.0 - 600.0	329.0	88	1
	Lower	0/7	ND	ND	2000[b]	0

Table 10.6.2
AOC 611
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (Upper Interval – 7 Samples plus 1 Duplicate Sample/Lower Interval – 7 Samples) (µg/kg)						
Dibenzofuran	Upper	0/7	ND	ND	31000	0
	Lower	1/7	74.0	74.0	240000	0
Fluorene	Upper	0/7	ND	ND	310000	0
	Lower	1/7	160.0	160.0	560000[a]	0
Fluoranthene	Upper	4/7	50.0 - 1600.0	491.25	310000	0
	Lower	1/7	200.0	200.0	4300000[a]	0
Indeno(1,2,3-cd)pyrene	Upper	3/7	81.5 - 1400.0	533.83	880	1
	Lower	0/7	ND	ND	14000[b]	0
Naphthalene	Upper	1/7	62.5	62.5	310000	0
	Lower	1/7	7400.0	7400.0	84000[a]	0
Phenanthrene	Upper	3/7	71.0 - 140.0	99.33	230000	0
	Lower	1/7	470.0	470.0	1380000	0
Pyrene	Upper	4/7	41.0 - 4100.0	1102.75	230000	0
	Lower	1/7	160.0	160.0	4200000[a]	0
Pesticides and PCBs (Upper Interval – 1 Duplicate Sample) (µg/kg)						
Aroclor-1260	Upper	1/1	370.0	370.0	320	1
	Lower	0/0	ND	ND	1000	0
Dieldrin	Upper	1/1	20.0	20.0	40	0
	Lower	0/0	ND	ND	4[b]	0

Table 10.6.2
AOC 611
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Pesticides and PCBs (Upper Interval – 1 Duplicate Sample) (μg/kg)						
gamma-Chlordane	Upper	1/1	7.6	7.6	490	0
	Lower	0/0	ND	ND	10000	0
Dioxins (Upper Interval – 1 Duplicate Sample) (ng/kg)						
Dioxin(2,3,7,8-TCDD TEQs)[1]	Upper	1/1	11.2665	11.2665	1000	0
	Lower	0/0				
pH						
pH	Upper	4/4	5.39 - 7.79	6.80	NL	NA
	Lower	4/4	4.47 - 7.84	5.53	NL	NA

Notes:

- a = Calculated values correspond to a noncancer hazard quotient of 1.
- b = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
- c = Soil saturation concentration (C_{sat}).
- d = SSL for pH of 6.8.
- 1 = Calculated from methods described in USEPA *Interim Supplemental Guidance to RAGS: Human Health Risk Assessment,* Bulletin 2 (USEPA, 1995a) (See Section 6).
- ND = Not detected
- NL = Not listed
- NA = Not applicable
- * = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
- mg/kg = Micrograms per kilogram
- ng/kg = Nanograms per kilogram

Table 10.6.3
AOC 611
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.[a] (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 7 Samples plus 1 Duplicate Sample/Lower Interval - 7 Samples) (mg/kg)						
Aluminum	Upper	7/7	6100.0 - 14300.0	10228.6	7800	5
	Lower	7/7	6150.0 - 15200.0	11290.0	1000000	0
Antimony	Upper	3/7	0.8 - 2.25	1.52	3.1	0
	Lower	1/7	0.6	0.6	5	0
Arsenic	Upper	7/7	5.3 - 145.0	27.91	0.43	7
	Lower	7/7	1.9 - 34.7	10.37	29[b]	1
Barium	Upper	7/7	11.1 - 177.0	63.81	550	0
	Lower	7/7	10.1 - 34.5	19.73	1600[b]	0
Beryllium	Upper	7/7	0.21 - 0.49	0.37	0.15	7
	Lower	6/7	0.24 - 0.47	0.29	63[b]	0
Cadmium	Upper	4/7	0.24 - 4.9	1.88	3.9	1
	Lower	1/7	1.5	1.5	8[b]	0
Calcium	Upper	7/7	802.0 - 11900.0	4568.14	NL	NA
	Lower	7/7	147.0 - 4040.0	1118.71	NL	NA
Chromium	Upper	7/7	14.8 - 61.4	27.3	39	1
	Lower	7/7	8.5 - 27.5	19.8	38[b]	0
Cobalt	Upper	7/7	1.6 - 13.1	4.41	470	0
	Lower	7/7	0.51 - 1.9	1.52	2000	0
Copper	Upper	7/7	0.94 - 746.0	135.1	310	1
	Lower	7/7	0.46 - 156.0	23.2	920	0

Table 10.6.3
AOC 611
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganic (Upper Interval - 7 Samples plus 1 Duplicate Sample/Lower Interval - 7 Samples) (mg/kg)						
Iron	Upper	7/7	8720.0 - 17600.0	13838.57	2300	6
	Lower	7/7	6250.0 - 30500.0	16878.57	NL	NA
Lead	Upper	7/7	7.1 - 566.5	201.4	400[c]	2
	Lower	7/7	6.1 - 70.8	19.09	400[c]	0
Magnesium	Upper	7/7	732.0 - 1260.0	935.79	NL	NA
	Lower	7/7	393.0 - 1190.0	953.71	NL	NA
Manganese	Upper	7/7	29.0 - 124.0	64.3	180	0
	Lower	7/7	16.1 - 74.7	54.4	1100	0
Mercury	Upper	6/7	0.07 - 16.7	4.07	2.3	2
	Lower	2/7	0.14 - 6.7	3.42	2.0[b]	1
Nickel	Upper	7/7	2.9 - 140.35	25.6	160	0
	Lower	7/7	1.1 - 4.4	2.97	130[b]	0
Potassium	Upper	6/7	322.0 - 594.0	431.83	NL	NA
	Lower	6/7	428.0 - 608.0	485.67	NL	NA
Selenium	Upper	7/7	0.39 - 1.0	0.65	39	0
	Lower	5/7	0.6 - 2.0	1.07	5[b]	0
Silver	Upper	1/7	1.7	1.7	39	0
	Lower	0/7	ND	ND	34[a,b]	0
Sodium	Upper	3/7	238.0 - 245.0	242	NL	NA
	Lower	3/7	242.0 - 288.0	258.0	NL	NA

Table 10.6.3
AOC 611
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganic (Upper Interval - 7 Samples plus 1 Duplicate Sample/Lower Interval - 7 Samples) (mg/kg)						
Thallium	**Upper**	**1/7**	**0.51**	**0.51**	**0.63**	**0**
	Lower	**2/7**	**0.78 - 0.87**	**0.83**	**1.24**	**0**
Vanadium	Upper	7/7	20.4 - 29.2	25.1	55	0
	Lower	7/7	11.7 - 40.4	26.9	6000[a]	0
Zinc	**Upper**	**7/7**	**10.9 - 1100.0**	**237.9**	**2300**	**0**
	Lower	**7/7**	**7.1 - 394.0**	**69.3**	**12000[a,b]**	**0**
Cyanide	Upper	1/1	0.16	0.16	160	0
	Lower	0/0	ND	ND	40 (amenable)	0

Notes:

- a = Calculated values correspond to a noncancer hazard quotient of 1.
- b = SSL for pH of 6.8.
- c = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
- ND = Not detected
- NL = Not listed
- NA = Not applicable
- * = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
- mg/kg = Milligrams per kilogram

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Carbon disulfide	**611SB002**	**ND**	**780000.0**	**NA**	**2.0**	**32000[a]**	**NA**
Ethylbenzene	611SB002	ND	780000	NA	11.0	13000	NA
	611SB004	16.0			ND		
Toluene	**611SB004**	**3.0**	**1600000**	**NA**	**ND**	**12000**	**NA**
Xylene (total)	611SB001	2.0	16000000	NA	50.0	210000	NA
	611SB002	ND			ND		
	611SB004	100.0					
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	**611SB002**	**191.2**	**88.0**	**NA**	**NA**	**NL**	**NA**
	611SB005	**4.9**			**NA**		
	611SB006	**4317.6**			**NA**		
	611SB007	**93.2**			**NA**		
2-Methylnaphthalene	611SB002	ND	310000	NA	130.0	126000	NA
	611SB005	ND			12000.0		
	611SB007	88.5			ND		
Acenaphthene	**611SB005**	**ND**	**470000**	**NA**	**160.0**	**570000[a]**	**NA**
Acenaphthylene	611SB006	720.0	310000	NA	ND	293000	NA
	611SB007	50.5			ND		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Anthracene	611SB002	54.0	2300000	NA	ND	12000000[a]	NA
	611SB005	ND			110.0		
	611SB006	540.0			ND		
	611SB007	44.5			ND		
Benzo(a)anthracene	611SB002	92.0	880.0	NA	ND	2000[b]	NA
	611SB005	ND			53.0		
	611SB006	1900.0			ND		
	611SB007	57.5			ND		
Benzo(a)pyrene	611SB002	110.0	88.0	NA	ND	8000	NA
	611SB006	3000.0			ND		
	611SB007	70.0			ND		
Benzo(b)fluoranthene	611SB005	49.0	880.0	NA	ND	5000[b]	NA
	611SB006	3500.0			ND		
	611SB007	83.5			ND		
Benzo(g,h,i)perylene	611SB002	150.0	230000.0	NA	ND	4.66E+08	NA
	611SB003	44.0			ND		
	611SB006	1400.0			ND		
	611SB007	140.0			ND		
Benzo(k)fluoranthene	611SB002	180.0	8800.0	NA	ND	49000[b]	NA
	611SB006	3400.0			ND		
	611SB007	85.5			ND		
Benzoic acid	611SB006	61.0	31000000	NA	ND	400000[a,c]	NA
	611SB007	110.0					

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Chrysene	611SB002	150.0	88000.0	NA	ND	160000[b]	NA
	611SB005	45.0			51.0		
	611SB006	3600.0			ND		
	611SB007	91.0			ND		
Di-n-butylphthalate	611SB007	65.0	780000	NA	ND	2300000[d]	NA
Di-n-octylphthalate	611SB002	54.0	160000	NA	ND	10000000[d]	NA
	611SB003	240.0			ND		
Dibenz(a,h)anthracene	611SB002	58.0	88	NA	ND	2000[b]	NA
	611SB006	600.0			ND		
Dibenzofuran	611SB005	ND	31000	NA	74.0	240000	
Fluoranthene	611SB002	200.0	310000.0	NA	ND	4300000[a]	NA
	611SB005	50.0			200.0		
	611SB006	1600.0			ND		
	611SB007	115.0			ND		
Fluorene	611SB005	ND	310000	NA	160.0	560000[a]	NA
Indeno(1,2,3-cd)pyrene	611SB002	120.0	880	NA	ND	14000[b]	NA
	611SB006	1400.0			ND		
	611SB007	81.5			ND		
Naphthalene	611SB005	ND	310000	NA	7400.0	84000[a]	NA
	611SB007	62.5			ND		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Phenanthrene	**611SB002**	**71.0**	**230000.0**	**NA**	**ND**	**1380000**	**NA**
	611SB005	**ND**			**470.0**		
	611SB006	**140.0**			**ND**		
	611SB007	**87.0**			**ND**		
Pyrene	611SB002	160.0	230000.0	NA	ND	4200000[a]	NA
	611SB005	41.0			160.0		
	611SB006	4100.0			ND		
	611SB007	110.0			ND		
Pesticides and PCBs (μg/kg)							
Dieldrin	**611SB007**	**20.0**	**40**	**NA**	**NT**	**4[b]**	**NA**
gamma-Chlordane	611SB007	7.6	490	NA	NT	10000	NA
Aroclor-1260	**611SB007**	**370.0**	**320**	**NA**	**NT**	**1000**	**NA**
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	**611SB007**	**11.2665**	**1000**	**NA**	**ND**	**1900**	**NA**

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	611SB001	11500.0	7800.0	18500	13900.0	1000000	17100
	611SB002	6100.0			6960.0		
	611SB003	11500.0			9620.0		
	611SB004	8980.0			6150.0		
	611SB005	14300.0			13300.0		
	611SB006	7470.0			15200.0		
	611SB007	11750.0			13900.0		
Antimony (Sb)	611SB005	0.8	3.1	0.79	ND	5	NL
	611SB006	1.5			0.6		
	611SB007	2.25			ND		
Arsenic (As)	611SB001	7.9	0.43	19.9	9.8	29[c]	18.2
	611SB002	145.0			34.7		
	611SB003	5.3			4.8		
	611SB004	5.9			1.9		
	611SB005	7.2			2.4		
	611SB006	11.5			12.7		
	611SB007	12.6			6.3		
Barium (Ba)	611SB001	27.0	550.0	61.5	21.8	1600[c]	51.8
	611SB002	177.0			34.5		
	611SB003	25.9			15.3		
	611SB004	11.1			10.1		
	611SB005	34.5			18.1		
	611SB006	55.7			23.0		
	611SB007	115.5			15.3		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC[a] (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL[a] (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Beryllium (Be)	**611SB001**	**0.37**	**0.15**	**1.05**	**0.47**	**63^c**	**1.20**
	611SB002	**0.49**			**0.28**		
	611SB003	**0.42**			**0.26**		
	611SB004	**0.21**			**ND**		
	611SB005	**0.39**			**0.24**		
	611SB006	**0.37**			**0.31**		
	611SB007	**0.36**			**0.32**		
Cadmium (Cd)	611SB002	**4.9**	3.9	0.26	1.5	8^c	0.09
	611SB005	0.24			ND		
	611SB006	0.92			ND		
	611SB007	1.45			ND		
Calcium (Ca)	**611SB001**	**1800.0**	NL	**NL**	**562.0**	**NL**	**NL**
	611SB002	**11900.0**			**4040.0**		
	611SB003	**1400.0**			**182.0**		
	611SB004	**802.0**			**147.0**		
	611SB005	**9920.0**			**383.0**		
	611SB006	**3640.0**			**2020.0**		
	611SB007	**2515.0**			**497.0**		
Chromium (Cr)	611SB001	20.1	39 VI 7800 III	34.8	27.2	38^c (total)	32.2
	611SB002	33.9			16.2		
	611SB003	17.0			16.4		
	611SB004	14.8			8.5		
	611SB005	61.4			21.5		
	611SB006	23.4			21.3		
	611SB007	20.5			27.5		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Cobalt (Co)	**611SB001**	**1.6**	**470.0**	**15.1**	**1.8**	**2000**	**6.85**
	611SB002	**3.0**			**1.5**		
	611SB003	**13.1**			**1.6**		
	611SB004	**3.8**			**0.51**		
	611SB005	**3.0**			**1.5**		
	611SB006	**2.7**			**1.9**		
	611SB007	**3.7**			**1.8**		
Copper (Cu)	611SB001	21.1	310.0	48.2	1.2	920	30.4
	611SB002	746.0			156.0		
	611SB003	5.5			0.53		
	611SB004	0.94			0.46		
	611SB005	38.9			0.59		
	611SB006	78.2			1.2		
	611SB007	54.95			2.4		
Cyanide (CN)	**611SB007**	**0.16**	**160.0**	**0.29**	**ND**	**40 (Amenable)**	**0.24**
Iron (Fe)	611SB001	1510.00	2300.0	NL	30500.0	NL	NL
	611SB002	17600.0			12600.0		
	611SB003	13900.0			14200.0		
	611SB004	12400.0			6250.0		
	611SB005	13100.0			12700.0		
	611SB006	8720.0			20100.0		
	611SB007	16050.0			21800.0		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Lead(Pb)	**611SB001**	**19.6**	**400.0[c]**	**180**	**12.2**	**400[e]**	**51.7**
	611SB002	**400.0**			**70.8**		
	611SB003	**22.9**			**7.4**		
	611SB004	**7.1**			**6.1**		
	611SB005	**84.8**			**8.4**		
	611SB006	**309.0**			**12.0**		
	611SB007	**566.5**			**16.7**		
Magnesium (Mg)	611SB001	899.0	NL	NL	1070.0	NL	NL
	611SB002	907.0			793.0		
	611SB003	1040.0			1020.0		
	611SB004	732.0			393.0		
	611SB005	1260.0			1190.0		
	611SB006	896.0			1080.0		
	611SB007	816.5			1130.0		
Manganese (Mn)	**611SB001**	**34.1**	180.0	**307**	**74.7**	**1100**	**469**
	611SB002	**124.0**			**56.2**		
	611SB003	**49.8**			**65.8**		
	611SB004	**29.0**			**16.1**		
	611SB005	**64.6**			**69.2**		
	611SB006	**87.9**			**33.2**		
	611SB007	**60.6**			**65.3**		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Mercury (Hg)	611SB001	**2.3**	2.3	**0.62**	**ND**	**2.0[c]**	**0.23**
	611SB002	**16.7**			**6.7**		
	611SB004	0.07			**ND**		
	611SB005	**1.6**			**ND**		
	611SB006	**2.2**			**ND**		
	611SB007	**1.55**			**0.14**		
Nickel (Ni)	611SB001	3.7	160.0	12.6	2.9	130[c]	8.85
	611SB002	10.0			3.7		
	611SB003	5.4			2.2		
	611SB004	2.9			1.1		
	611SB005	8.1			2.9		
	611SB006	8.9			3.6		
	611SB007	140.35			4.4		
Potassium (K)	611SB001	**413.0**	NL	**NL**	**480.0**	**NL**	**NL**
	611SB002	**448.0**			**454.0**		
	611SB003	**594.0**			**445.0**		
	611SB004	**339.0**			**ND**		
	611SB005	**475.0**			**499.0**		
	611SB006	**ND**			**428.0**		
	611SB007	**322.0**			**608.0**		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Selenium (Se)	611SB001	0.39	39.0	1.15	2.0	5[c]	1.24
	611SB002	1.0			0.6		
	611SB003	0.97			ND		
	611SB004	0.39			ND		
	611SB005	0.51			0.65		
	611SB006	0.51			1.0		
	611SB007	0.79			1.1		
Silver (Ag)	611SB003	1.7	39.0	1.85	ND	34[a,c]	ND
Sodium (Na)	611SB005	243.0	NL	NL	242.0	NL	NL
	611SB006	245.0			243.0		
	611SB007	238.0			288.0		
Thallium (Tl)	611SB006	ND	0.63	NL	0.78	1.24	1.24
	611SB007	0.51			0.87		
Vanadium (V)	611SB001	29.2	55.0	48.9	40.4	6000[d]	49.4
	611SB002	20.4			18.9		
	611SB003	27.4			27.4		
	611SB004	24.6			11.7		
	611SB005	28.7			24.0		
	611SB006	22.7			31.7		
	611SB007	22.85			34.4		

Table 10.6.4
AOC 611
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Zinc (Zn)	611SB001	40.1	2300.0	198	18.4	12000[a,c]	84.2
	611SB002	1100.0			394.0		
	611SB003	31.6			12.4		
	611SB004	10.9			7.1		
	611SB005	100.0			14.9		
	611SB006	232.0			18.6		
	611SB007	150.5			19.6		
pH							
pH	611SB001	7.42	NL	NA	4.8	NL	NA
	611SB002	7.79			7.84		
	611SB003	6.59			5.01		
	611SB004	5.39			4.47		

Notes:

a	=	Calculated values correspond to a noncancer hazard quotient of 1.
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c	=	SSL for pH of 6.8.
d	=	Soil saturation concentration (C_{sat}).
e	=	A screening level of 400 mg/kg/ has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995a) (See Section 6).
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
NA	=	Not applicable
ND	=	Not detected

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.

All background reference values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background reference values for groundwater are based on two sampling rounds in two wells at each depth.

Pesticides and PCBs in Soil

Aroclor-1260, exceeded its RBC in surface soil. Figure 10.6-3 shows the PCB, Aroclor-1260, concentrations in surface soil. No pesticides exceeded their respective RBCs in the duplicate sample.

Other Organic Compounds in Soil

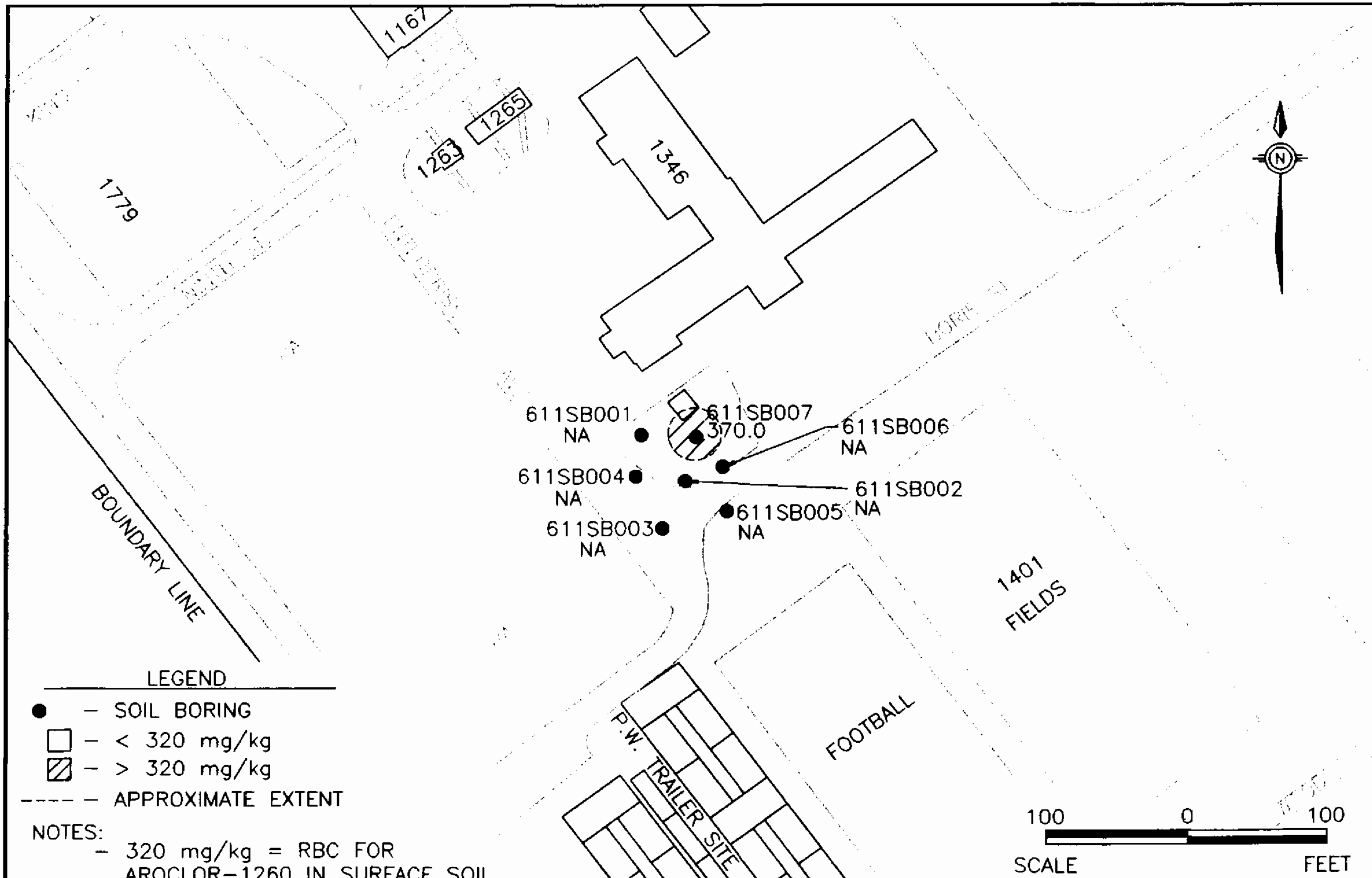
Dioxin (2,3,7,8-TCDD TEQ) was detected in surface soil below its RBC in the duplicate sample.

Inorganic Elements in Soil

Twenty-three metals and cyanide were detected in soil samples collected at AOC 611. Arsenic, cadmium, chromium, copper, lead, and mercury were detected above both their respective RBCs and background concentrations for Zone F surface soil. Arsenic and mercury exceeded their respective SSLs and background concentrations for Zone F. Figures 10.6-4 through 10.6-11 show surface/subsurface metals concentrations that exceeded both their respective RBC/SSL and background concentrations.

pH in Soil

Soil samples from the four original locations were analyzed for pH. The surface soils all exhibited a normal range of pH. Three of the subsurface soil sample locations exhibited slightly acidic conditions.



LEGEND

- ● – SOIL BORING
- □ – < 320 mg/kg
- ▨ – > 320 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 320 mg/kg = RBC FOR AROCLOR–1260 IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- NA = SAMPLE NOT ANALYZED FOR PCBs

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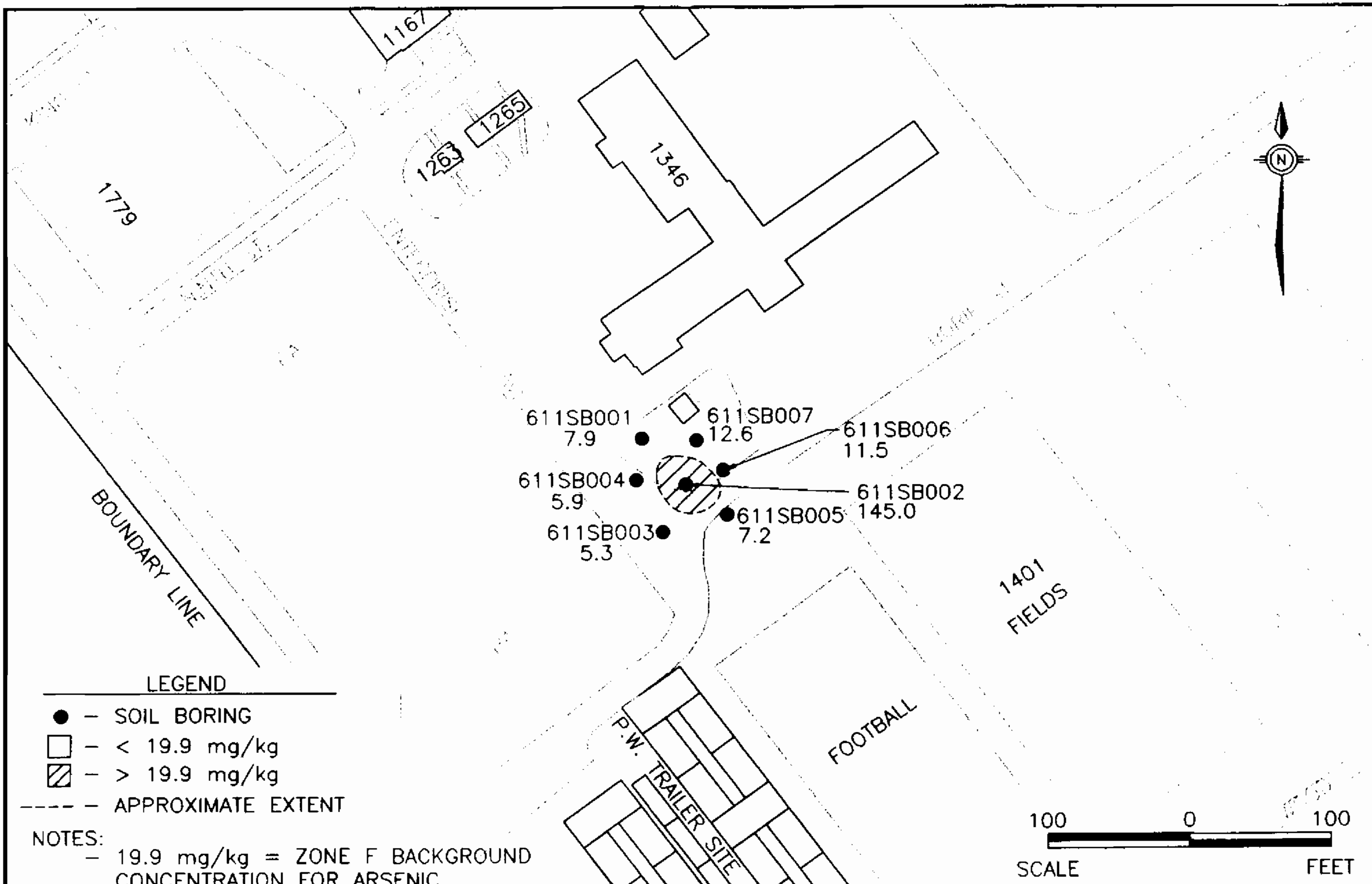
FIGURE 10.6–3
AROCLOR–1260 IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906SSAR



LEGEND

- ● – SOIL BORING
- □ – < 19.9 mg/kg
- ▨ – > 19.9 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 19.9 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN SURFACE SOIL
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

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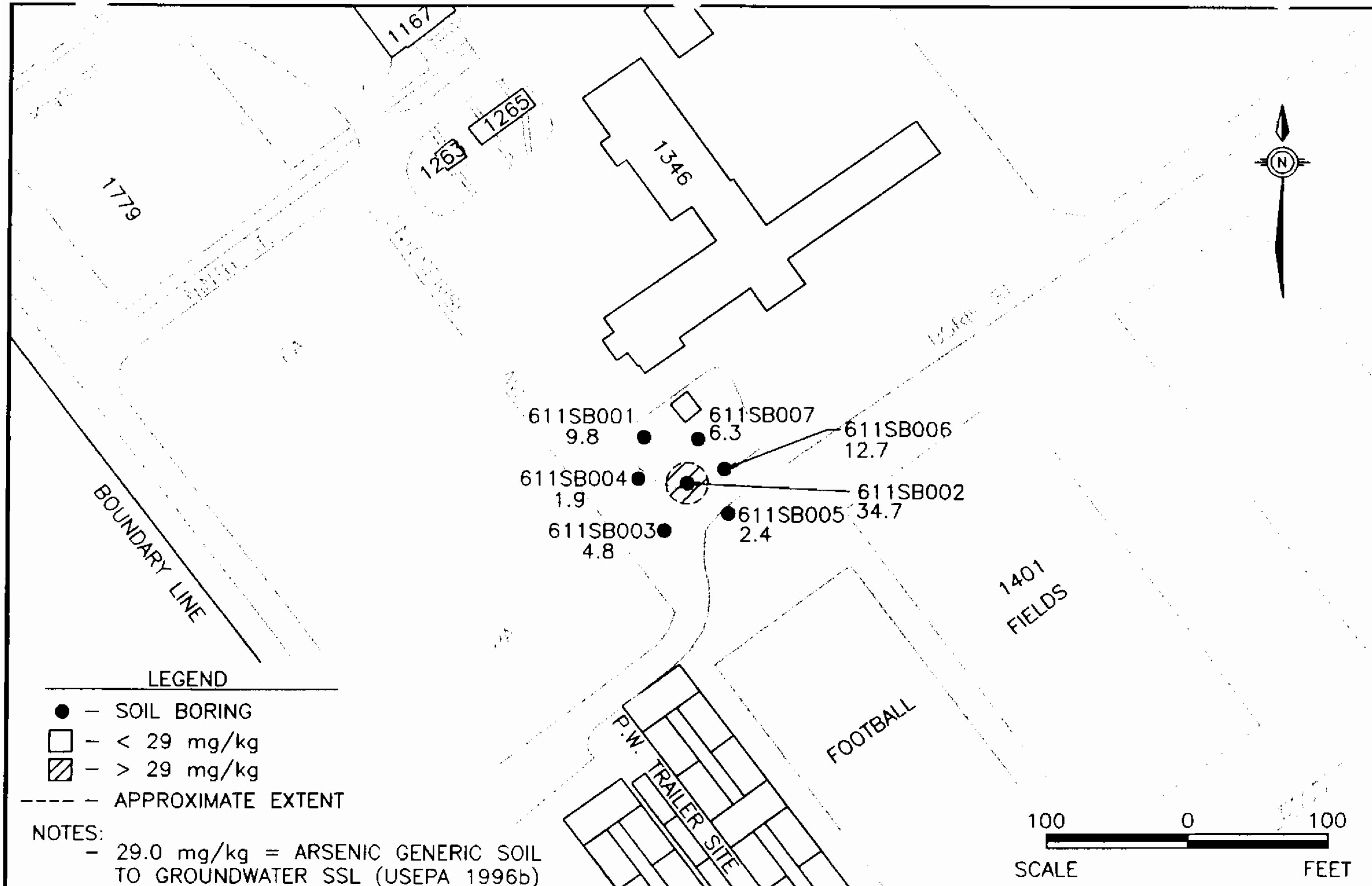
FIGURE 10.6–4
ARSENIC IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97	DWG NAME: 2906SSAS



LEGEND

- ● – SOIL BORING
- □ – < 29 mg/kg
- ▨ – > 29 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 29.0 mg/kg = ARSENIC GENERIC SOIL TO GROUNDWATER SSL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

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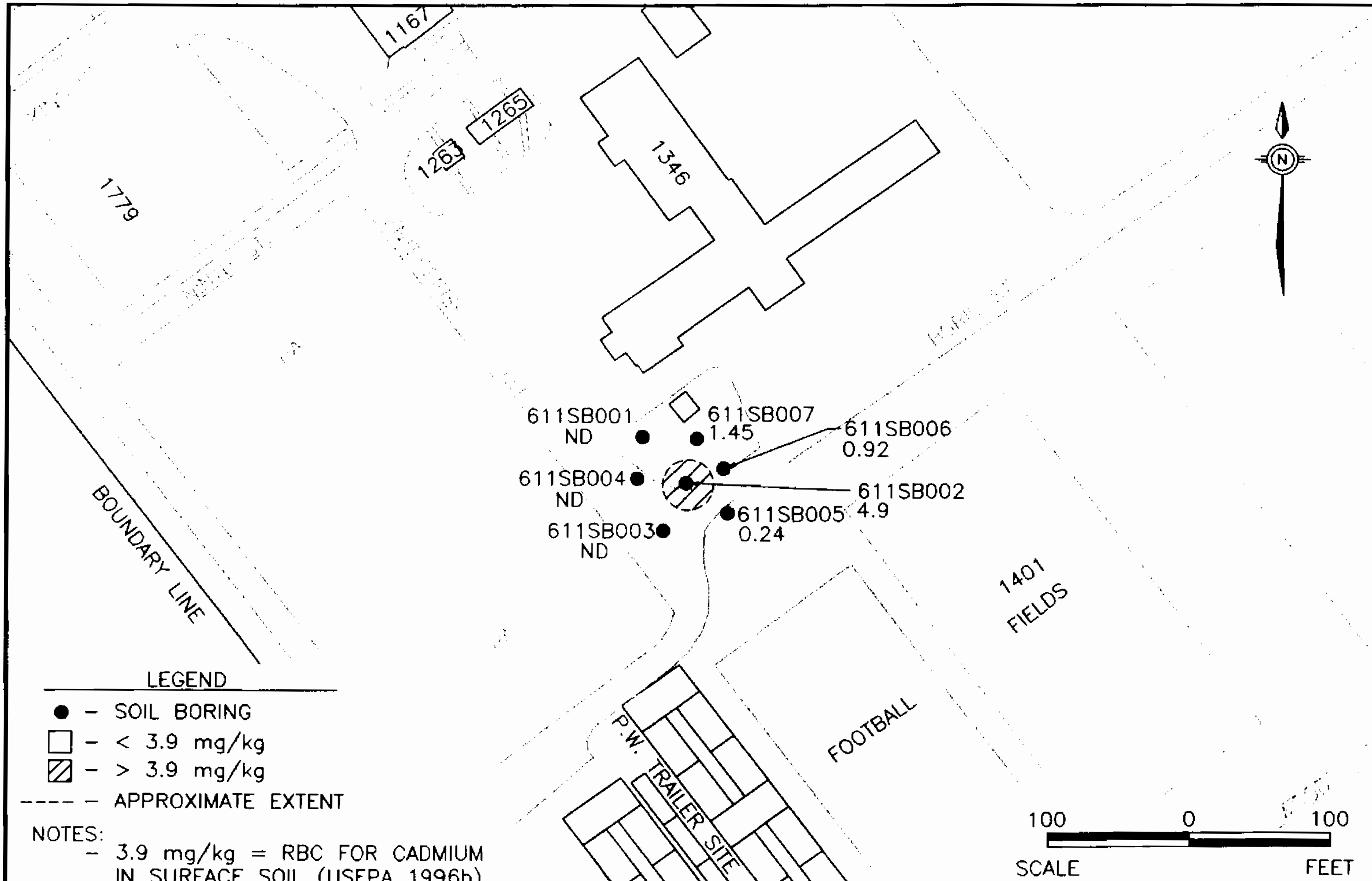
FIGURE 10.6-5
ARSENIC IN SUBSURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906A611



NOTES:
- 3.9 mg/kg = RBC FOR CADMIUM IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

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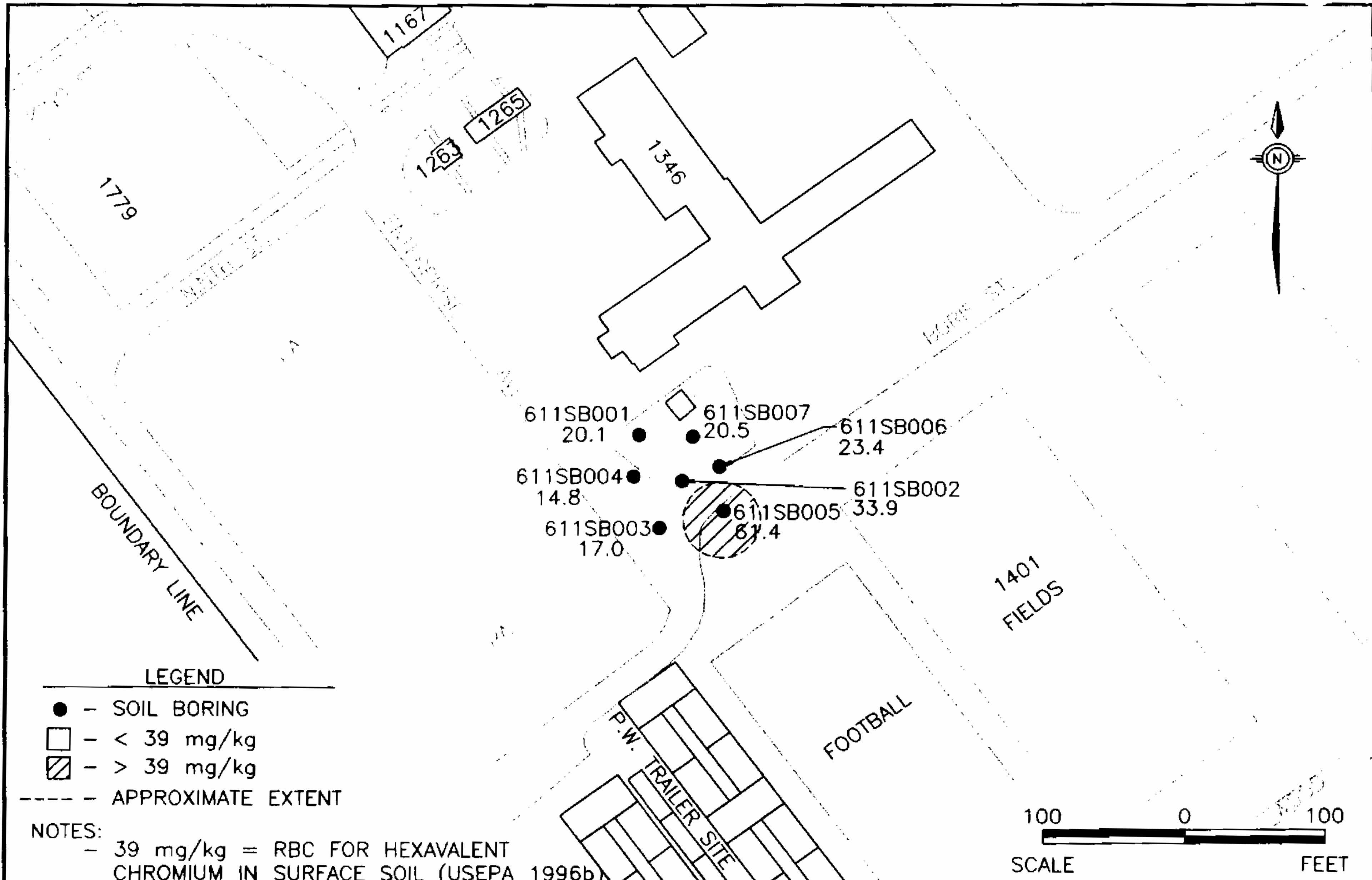
FIGURE 10.6-6
CADMIUM IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906C611



LEGEND

- ● – SOIL BORING
- □ – < 39 mg/kg
- ▨ – > 39 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 39 mg/kg = RBC FOR HEXAVALENT CHROMIUM IN SURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

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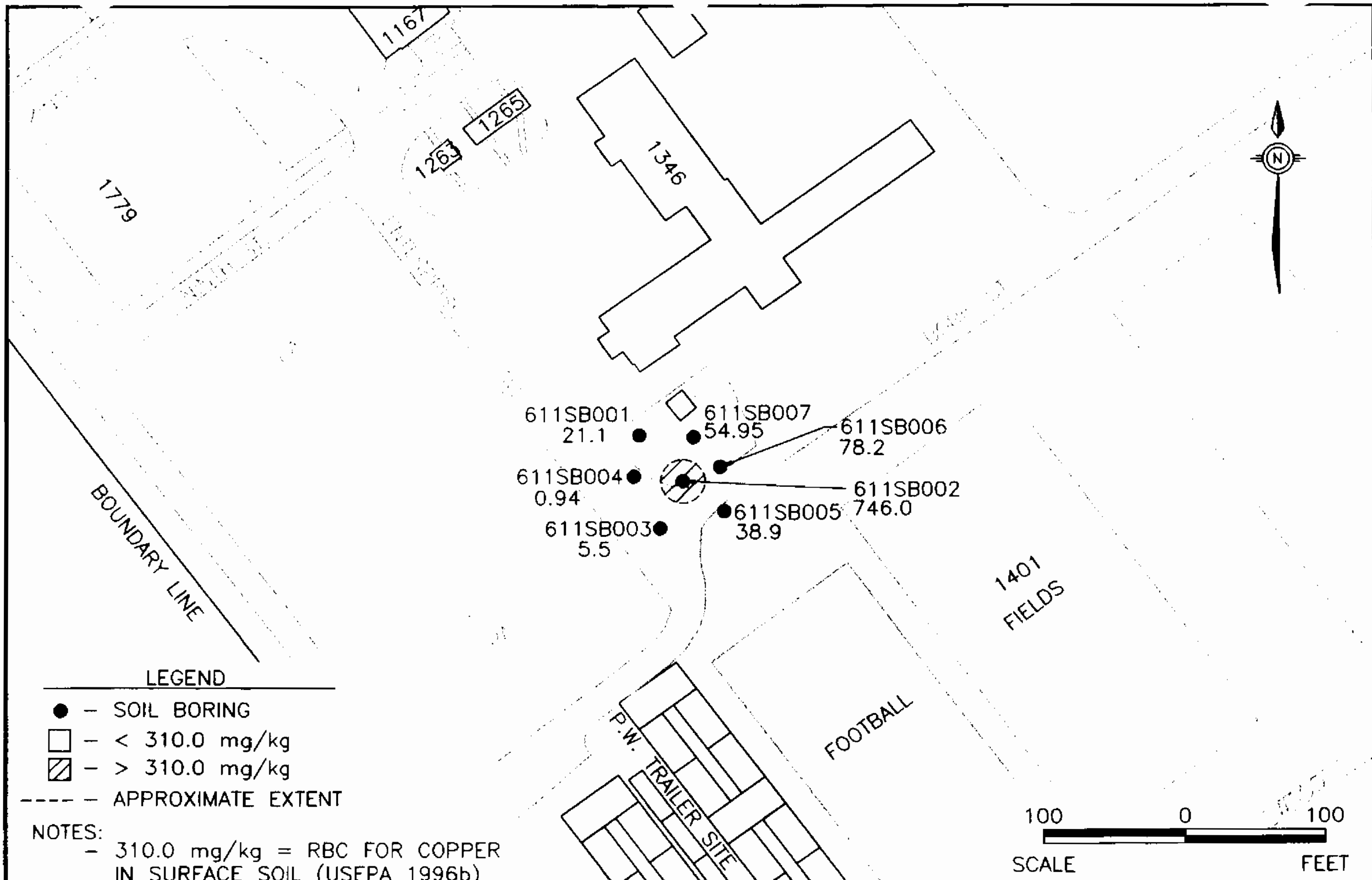
FIGURE 10.6–7
CHROMIUM IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906CH61



LEGEND

- ● – SOIL BORING
- □ – < 310.0 mg/kg
- ▨ – > 310.0 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- – 310.0 mg/kg = RBC FOR COPPER IN SURFACE SOIL (USEPA 1996b)
- – THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

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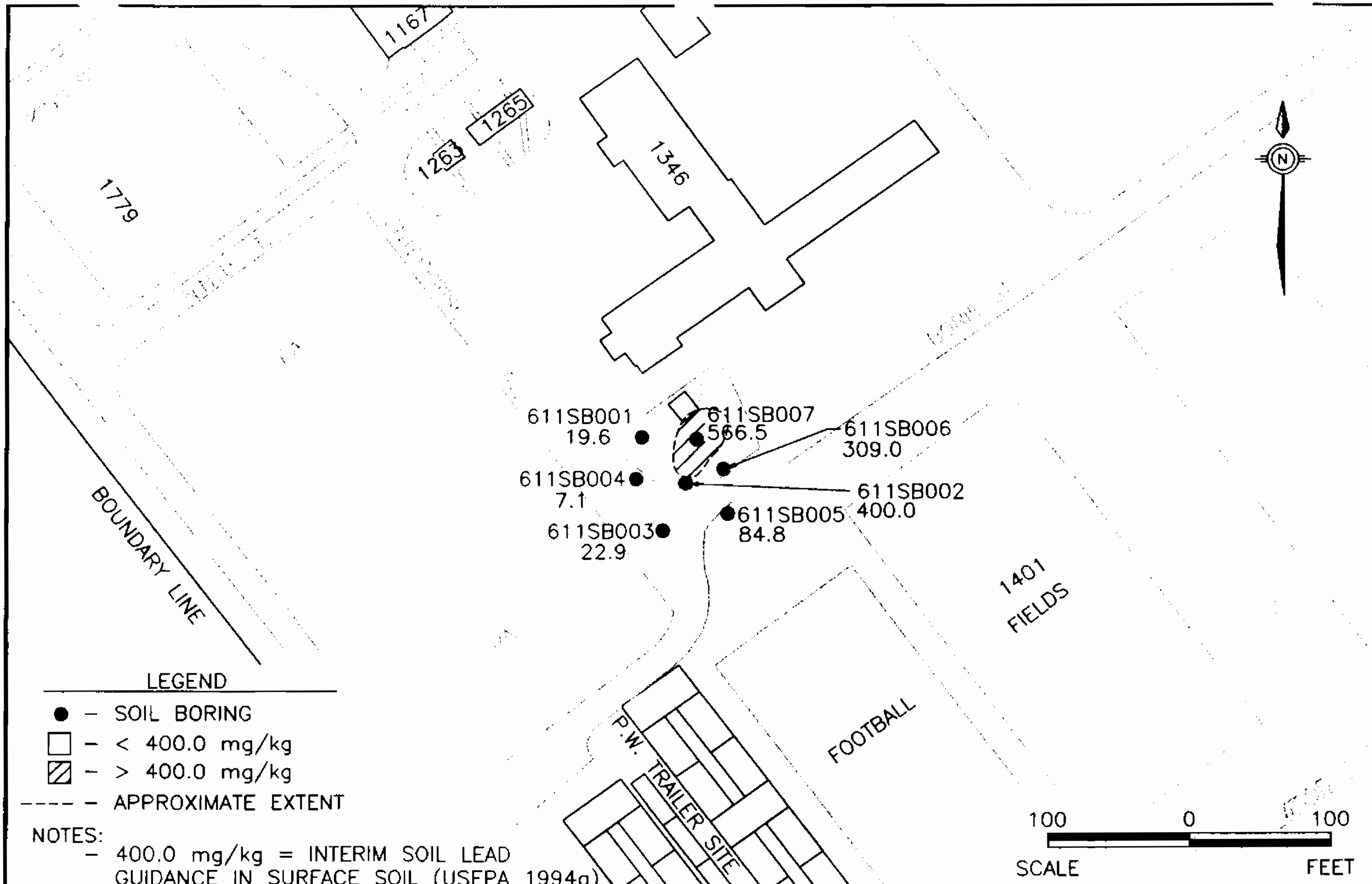
FIGURE 10.6-8
COPPER IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906CPSS



LEGEND

- ● – SOIL BORING
- □ – < 400.0 mg/kg
- ▨ – > 400.0 mg/kg
- ---- – APPROXIMATE EXTENT

NOTES:
- 400.0 mg/kg = INTERIM SOIL LEAD GUIDANCE IN SURFACE SOIL (USEPA 1994a)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

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FIGURE 10.6-9
LEAD IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97	DWG NAME: 2906LDSS

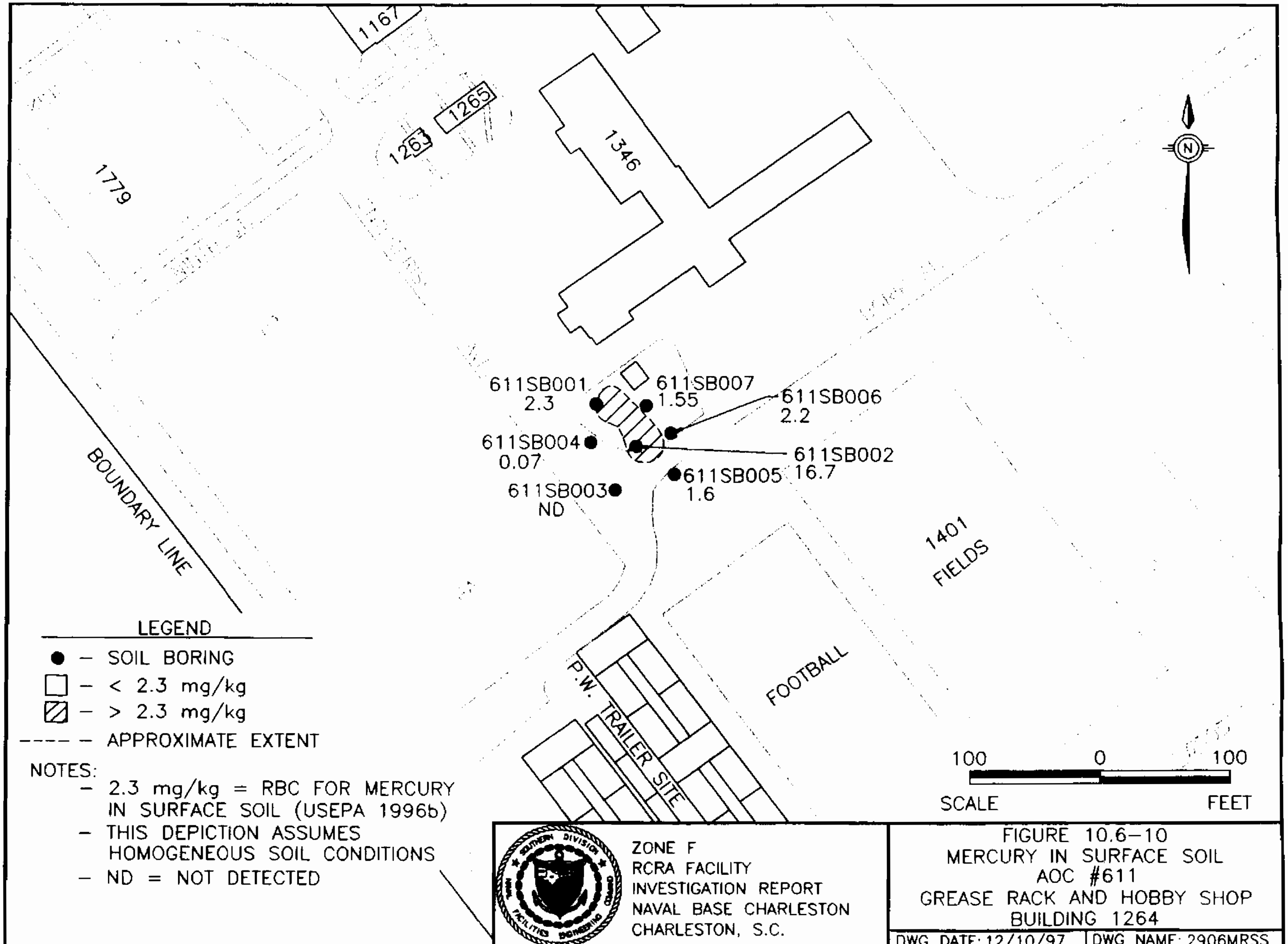

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FIGURE 10.6–10
MERCURY IN SURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906MRSS

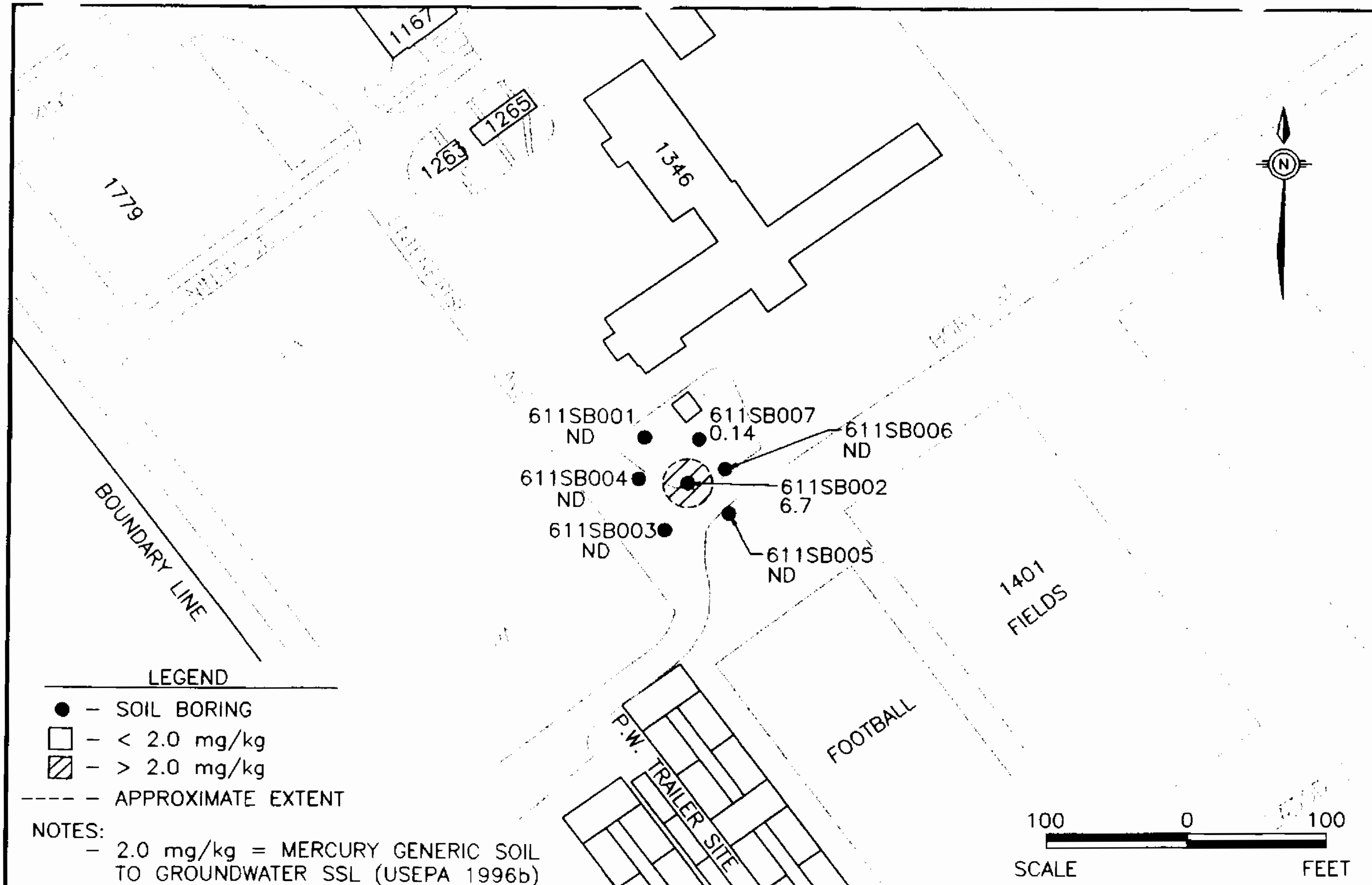

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FIGURE 10.6-11
MERCURY IN SUBSURFACE SOIL
AOC #611
GREASE RACK AND HOBBY SHOP
BUILDING 1264

DWG DATE: 12/10/97 | DWG NAME: 2906MRSB

10.6.4 Fate and Transport Assessment for AOC 611

Environmental media sampled as part of the AOC 611 investigation include surface and subsurface soil. Potential constituent migration pathways investigated for AOC 611 include soil-to-groundwater, and emission of volatiles from surface soil-to-air.

10.6.4.1 Soil-to-Groundwater Cross-Media Transport

Table 10.6.5 compares maximum detected organic constituent concentrations in surface and subsurface soil samples to groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) RBCs, or (b) background concentrations. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

One organic — dieldrin — was detected above its applicable SSL in surface soil at one duplicate location. This distribution is consistent with a surface application of dieldrin, and its strong affinity to adsorb to soil media, thereby limiting its mobility and attenuating its concentrations with depth in the soil column. Dieldrin in surface soil is normally temporally persistent as well, exhibiting very slow breakdown over time.

Five inorganics — arsenic, chromium, lead, mercury and nickel — exceeded their respective SSLs in surface soil. These exceedances were primarily limited to two locations 611SB002 and 611SB007. Chromium was detected in 611SB005. Only two of these exceedances — arsenic and mercury — were detected above the applicable SSL in subsurface soil, at location 611SB002. Notably, most inorganics exhibited a remarkable attenuation of concentration in the subsurface: arsenic concentration diminished by a factor of more than 4, chromium by more than 2, lead by more than 5, mercury by more than 2, and nickel by more than 31. This depletion in inorganic concentration is consistent with a surficial source, and in the absence of a mobilizing agent, the

Table 10.6.5
Chemicals Detected in Surface and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 611
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Carbon disulfide	ND	2	NA	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	16	11	NA	NA	13000	1300	4.3	UG/KG	UG/L	NO	NO	NO
Toluene	3	ND	NA	NA	12000	750	37	UG/KG	UG/L	NO	NO	NO
Xylene (total)	100	50	NA	NA	142000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	160	NA	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	720	ND	NA	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	540	110	NA	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	110	ND	NA	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	1400	ND	NA	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	1900	53	NA	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	3000	ND	NA	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	3500	ND	NA	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	3400	ND	NA	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	3600	51	NA	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	600	ND	NA	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	1400	ND	NA	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	74	NA	NA	120000	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	65	ND	NA	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Di-n-octylphthalate	240	ND	NA	NA	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	1600	200	NA	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	160	NA	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	88.5	12000	NA	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	62.5	7400	NA	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	140	470	NA	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	4100	160	NA	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	370	NA	NA	NA	1000	0.033	0.03	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	7.6	NA	NA	NA	10000	0.052	0.004	UG/KG	UG/L	NO	NO	NO
Dieldrin	20	NA	NA	NA	4	0.0042	0.0019	UG/KG	UG/L	YES	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	11.2665	NA	NA	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	14300	15200	NA	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	2.25	0.6	NA	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	145	34.7	NA	NA	29	16.7	36	MG/KG	UG/L	YES	NO	NO
Barium	177	34.5	NA	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.49	0.47	NA	NA	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	4.9	1.5	NA	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	61.4	27.5	NA	NA	38	180	50	MG/KG	UG/L	YES	NO	NO
Cobalt	13.1	1.9	NA	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	746	156	NA	NA	920	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.16	NA	NA	NA	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	567	70.8	NA	NA	400	15	8.5	MG/KG	UG/L	YES	NO	NO
Manganese	124	74.7	NA	NA	1100	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	16.7	6.7	NA	NA	2	11	0.025	MG/KG	UG/L	YES	NO	NO
Nickel	140	4.4	NA	NA	130	730	61.1	MG/KG	UG/L	YES	NO	NO
Selenium	1	2	NA	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	1.7	ND	NA	NA	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Thallium	0.51	0.87	NA	NA	1.24	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Vanadium	29.2	40.4	NA	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO

Table 10.6.5
Chemicals Detected in Surface and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 611
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Zinc	1100	394	NA	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background reference value.

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

tendency for inorganics to adsorb onto soil media. The nature of the exceedances is consistent with past site activities, namely disposal of battery acids (enriched with metals) and lead. Overall, the occurrence of both inorganic and organic exceedances does not cover a large area horizontally. With regard to the soil to groundwater pathway, data are available from other sites in this zone that suggest that arsenic at similar concentrations in subsurface soil is not leaching to shallow groundwater. Additionally, given the persistent presence of arsenic zone-wide in both soil and groundwater, consideration should be given that soil subsurface soil concentrations are within the range of ambient conditions. The presence of mercury is inconsistent with other zone sites, therefore, the soil-to-groundwater migration pathway may have merit. Evaluation of the pathway should be focused however, given that a risk-based evaluation is consistently invalid given the lack of resource use.

10.6.4.2 Soil-to-Air Cross-Media Transport

Table 10.6.6 lists the VOCs detected in surface soil samples collected at AOC 611, along with corresponding soil-to-air volatilization screening levels. No VOCs were detected in site soil that exceeded applicable screening levels, therefore the migration pathway is invalid.

10.6.4.3 Fate and Transport Summary

One organic and five inorganics were present in surface soil above applicable SSLs. However, subsurface SSL exceedances were limited to two inorganics, arsenic and mercury. Distribution of soil exceedances exhibited remarkable attenuation as a function of depth within the soil column. Both the nature and vertical extent of these constituents is consistent with past site activities of surface disposal of wastes, including battery acid and lead. Attenuation with depth is a reflection of the soils ability to adsorb these constituents in the absence of a mobilizing agent. While no AOC specific groundwater data are available, empirical zone-wide data suggest that arsenic at similar concentrations will not leach at appreciable concentrations into shallow groundwater under typical conditions. Less data is available regarding mercury leachability, however, and the

Table 10.6.6
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone F: AOC 611
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Ethylbenzene	16	400000	UG/KG	NO
Toluene	3	650000	UG/KG	NO
Xylene (total)	100	410000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996.

NA - Not available

soil-to-groundwater pathway for this constituent may have merit. Regardless of the leachability to groundwater, however, the pathway screening for groundwater is risk-based, a pathway which is consistently invalid due to the lack of resource use. The groundwater to surface water migration pathway has not been evaluated with this AOC. However, the nearest receptor (the Cooper River) is 1,800 feet to the northeast, and data from the nearest site (AOC 609, 150 feet to the north) indicates that local groundwater flow is to the southeast. Both of these factors would suggest that the surface water discharge pathway would be invalid at AOC 611. The soil-to-air volatilization pathway at this AOC is unsubstantiated by the data and is considered insignificant.

10.6.5 Human Health Risk Assessment for AOC 611

10.6.5.1 Site Background and Investigative Approach

AOC 611 is the former Building 1264, which was used as an automotive hobby shop from the late 1950s to the early 1960s. The building has since been demolished and the site incorporated into a partially asphalt-paved and grass covered area. Materials released, stored, or disposed of at the site included petroleum products, antifreeze, isopropyl alcohol, solvents, degreasers, enamel paint, paint thinner, battery acid, and lead.

During the CSI, a total of 14 soil samples were collected from the upper and lower intervals of seven boring locations to identify potential impacts resulting from the activities listed above. Eight soil samples were collected from four initial soil borings in September 1996 and seven (six samples and one duplicate) soil samples from three additional soil borings were included in January 1997. Surface soil samples from all seven boring locations were used to quantitatively assess soil exposure pathways. Section 10.6.3 provides a summary of the sampling effort for AOC 611 soil.

10.6.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.6.7, COPCs identified in surface soil include Aroclor-1260, benzo(a)pyrene equivalents, arsenic, cadmium, chromium, copper, lead, and mercury. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

No groundwater samples were collected; however, the site lies within the monitoring well grid for adjacent AOC 609.

10.6.5.3 Exposure Assessment

Exposure Setting

AOC 611 is in an industrial setting on the former naval base, near the western boundary of the installation. At least half of the site is covered with asphalt, which would prevent direct contact with soil and would inhibit migration of potential contaminants to groundwater or air. All potable water is provided through the city's water supply. Groundwater is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (much of the area is paved). Therefore, future worker assessment is considered to be conservatively representative of current site users.

Table 10.6.7
Chemicals Present in Site Samples
AOC 611 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		creening Concentration RBC	Reference	Units	Number Exceeding RBC	Ref.
PCBs													
Aroclor-1260	*	1	1	370	370	370	NA	NA	320	NA	UG/KG	1	
Carcinogenic PAHs													
B(a)P Equiv.	*	4	7	4.945	4317.6	1152	450.645	473.755	88	NA	UG/KG	3	
Benzo(a)anthracene	*	3	7	57.5	1900	683	185	205	880	NA	UG/KG	1	
Benzo(b)fluoranthene	*	3	7	49	3500	1211	195	205	880	NA	UG/KG	1	
Chrysene		4	7	45	3600	972	195	205	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	2	7	58	600	329	185	205	88	NA	UG/KG	1	
Indeno(1,2,3-cd)pyrene	*	3	7	81.5	1400	534	185	205	880	NA	UG/KG	1	
Benzo(k)fluoranthene		3	7	85.5	3400	1222	185	205	8800	NA	UG/KG		
Benzo(a)pyrene	*	3	7	70	3000	1060	185	205	88	NA	UG/KG	2	
TCDD Equivalents													
Dioxin Equiv.		1	1	11.2665	11.2665	11.3	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		1	1	24.3	24.3	24.3	NA	NA	NA	NA	NG/KG		
1234678-HpCDF		1	1	15.8	15.8	15.8	NA	NA	NA	NA	NG/KG		
123678-HxCDD		1	1	2.52	2.52	2.52	NA	NA	NA	NA	NG/KG		
123678-HxCDF		1	1	4.34	4.34	4.34	NA	NA	NA	NA	NG/KG		
234678-HxCDF		1	1	12.5	12.5	12.5	NA	NA	NA	NA	NG/KG		
123478-HxCDF		1	1	30.8	30.8	30.8	NA	NA	NA	NA	NG/KG		
OCDD		1	1	125	125	125	NA	NA	NA	NA	NG/KG		
OCDF		1	1	23.5	23.5	23.5	NA	NA	NA	NA	NG/KG		
12378-PeCDD		1	1	5.15	5.15	5.15	NA	NA	NA	NA	NG/KG		
23478-PeCDF		1	1	5.6	5.6	5.60	NA	NA	NA	NA	NG/KG		
12378-PeCDF		1	1	6.52	6.52	6.52	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		7	7	6100	14300	10229	NA	NA	7800	18500	MG/KG	5	
Antimony (Sb)		3	7	0.8	2.25	1.52	0.175	0.7	3.1	0.79	MG/KG		3
Arsenic (As)	*	7	7	5.3	145	27.9	NA	NA	0.43	19.9	MG/KG	7	1
Barium (Ba)		7	7	11.1	177	63.8	NA	NA	550	61.5	MG/KG		2
Beryllium (Be)		7	7	0.21	0.49	0.37	NA	NA	0.15	1.05	MG/KG	7	
Cadmium (Cd)	*	4	7	0.24	4.9	1.88	0.025	0.025	3.9	0.26	MG/KG	1	3
Calcium (Ca)	N	7	7	802	11900	4568	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	7	7	14.8	61.4	27.3	NA	NA	39	34.8	MG/KG	1	1
Cobalt (Co)		7	7	1.6	13.1	4.41	NA	NA	470	15.1	MG/KG		
Copper (Cu)	*	7	7	0.94	746	135	NA	NA	310	48.2	MG/KG	1	3
Cyanide (CN)		1	1	0.16	0.16	0.16	NA	NA	160	0.29	MG/KG		
Iron (Fe)	N	7	7	8720	17600	13839	NA	NA	NA	NA	MG/KG		
Lead (Pb)	*	7	7	7.1	566.5	201	NA	NA	400	180	MG/KG	2	3
Magnesium (Mg)	N	7	7	732	1260	936	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		7	7	29	124	64.3	NA	NA	180	307	MG/KG		

Table 10.6.7
Chemicals Present in Site Samples
AOC 611 - Surface Soil
NAVBASE - Charleston
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		creening Concentration RBC	Reference	Units	Number Exceeding RBC	Ref.
Mercury (Hg)	*	6	7	0.07	16.7	4.07	0.02	0.02	2.3	0.62	MG/KG	2	5
Nickel (Ni)		7	7	2.9	140.35	25.6	NA	NA	160	12.6	MG/KG		1
Potassium (K)	N	6	7	322	594	432	119	119	NA	NA	MG/KG		
Selenium (Se)		7	7	0.39	1	0.65	NA	NA	39	1.15	MG/KG		
Silver (Ag)		1	7	1.7	1.7	1.70	0.105	0.115	39	1.85	MG/KG		
Sodium (Na)	N	3	7	238	245	242	62.5	186	NA	NA	MG/KG		
Thallium (Tl)		1	7	0.51	0.51	0.51	0.19	0.21	0.63	NA	MG/KG		
Vanadium (V)		7	7	20.4	29.2	25.1	NA	NA	55	48.9	MG/KG		
Zinc (Zn)		7	7	10.9	1100	238	NA	NA	2300	198	MG/KG		2
Pesticides													
gamma-Chlordane		1	1	7.6	7.6	7.60	NA	NA	490	NA	UG/KG		
Dieldrin		1	1	20	20	20.0	NA	NA	40	NA	UG/KG		
Semivolatile Organics													
Acenaphthylene		2	7	50.5	720	385	185	205	310000	NA	UG/KG		
Anthracene		3	7	44.5	540	213	185	205	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		4	7	44	1400	434	185	195	310000	NA	UG/KG		
Benzoic acid		2	7	61	110	85.5	900	1000	31000000	NA	UG/KG		
Di-n-butylphthalate		1	7	65	65	65.0	185	205	780000	NA	UG/KG		
Di-n-octyl phthalate		2	7	54	240	147	185	195	160000	NA	UG/KG		
Fluoranthene		4	7	50	1600	491	195	205	310000	NA	UG/KG		
2-Methylnaphthalene		1	7	88.5	88.5	88.5	185	205	310000	NA	UG/KG		
Naphthalene		1	7	62.5	62.5	62.5	185	205	310000	NA	UG/KG		
Phenanthrene		3	7	71	140	99.3	185	205	310000	NA	UG/KG		
Pyrene		4	7	41	4100	1103	195	205	230000	NA	UG/KG		
Volatile Organics													
Ethylbenzene		1	5	16	16	16.0	3	3	780000	NA	UG/KG		
Toluene		1	5	3	3	3.00	3	3	1600000	NA	UG/KG		
Xylene (Total)		2	5	2	100	51.0	3	3	16000000	NA	UG/KG		

* - Identified as a COPC
N - Essential nutrient
UG/KG - microgram per kilogram
MG/KG - milligram per kilogram
NG/KG - nanogram per kilogram
SQL - Sample quantitation limit
NA - Not applicable

The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for current and future site workers use are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. Table 10.6.8 presents the justification for exposure pathways assessed in this HHRA.

Table 10.6.8
Exposure Pathways Summary — AOC 611
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 611, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 611.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 611.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be representative of current receptors.

Table 10.6.8
Exposure Pathways Summary — AOC 611
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 611, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport did not identify any COPCs for this exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

Since less than ten samples were collected in surface soil, maximum detected concentrations were used EPCs, as discussed in Section 7 of this RFI.

Quantification of Exposure

CDIs for ingestion and dermal contact with surface soils are shown in Tables 10.6.9 and 10.6.10, respectively.

10.6.5.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.6.11 presents toxicological information specific to COPCs identified at AOC 611. This information was used in the quantification of risk/hazard associated with surface soil contaminants. Brief toxicological profiles for COPCs are provided below:

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingestion is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS, the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L of arsenic. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Table 10.6.9
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics							
Arsenic (As)	1	145	2.0E-04	1.9E-03	2.3E-04	7.1E-05	2.5E-05
Cadmium (Cd)	1	4.9	6.7E-06	6.3E-05	7.7E-06	2.4E-06	8.6E-07
Chromium (Cr)	1	61.4	8.4E-05	7.9E-04	9.6E-05	3.0E-05	1.1E-05
Copper (Cu)	1	746.0	1.0E-03	9.5E-03	1.2E-03	3.6E-04	1.3E-04
Lead (Pb)	1	566.5	NA	NA	NA	NA	NA
Mercury (Hg)	1	16.7	2.3E-05	2.1E-04	2.6E-05	8.2E-06	2.9E-06
Semivolatile Organics							
Benzo(a)pyrene equivalents	1	4.3	5.9E-06	5.5E-05	6.8E-06	2.1E-06	7.5E-07
PCBs							
Aroclor-1260	1	0.37	5.1E-07	4.7E-06	5.8E-07	1.8E-07	6.5E-08

NOTES:

lwa	Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
*	Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.6.10
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics								
Arsenic (As)	1	145	0.001	8.1E-06	2.7E-05	5.1E-06	5.8E-06	2.1E-06
Cadmium (Cd)	1	4.9	0.001	2.8E-07	9.1E-07	1.7E-07	2.0E-07	7.0E-08
Chromium (Cr)	1	61.4	0.001	3.4E-06	1.1E-05	2.2E-06	2.5E-06	8.8E-07
Copper (Cu)	1	746.0	0.001	4.2E-05	1.4E-04	2.6E-05	3.0E-05	1.1E-05
Lead (Pb)	1	566.5	0.001	NA	NA	NA	NA	NA
Mercury (Hg)	1	16.7	0.001	9.4E-07	3.1E-06	5.9E-07	6.7E-07	2.4E-07
Semivolatile Organics								
Benzo(a)pyrene equivalents	1	4.3	0.01	2.4E-06	8.0E-06	1.5E-06	1.7E-06	6.2E-07
PCBs								
Aroclor-1260	1	0.4	0.01	2.1E-07	6.9E-07	1.3E-07	1.5E-07	5.3E-08

NOTES:

CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
*	Reflects the estimated fraction of the site impacted by the corresponding COPC.
-	The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.6.11
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 611
NAVBASE Charleston, Zone F
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data									Carcinogenic Toxicity Data					
mical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
enic	0.0003	a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5	a	15.1	a	A	various
zo(a)pyrene Equivalents	NA		NA	NA	NA	NA	NA	NA	NA	7.3	a	6.1	c	B2	mutagen
imium (food)	0.001	a	H	proteinuria	10	NA	NA	NA	NA	NA		6.3	a	B1	lung
mium (water)	0.0005	a	H	proteinuria	10	NA	NA	NA	NA	NA		6.3	a	B1	lung
omium III	1	a	L	NA	100/10	NA	NA	NA	NA	NA		42	a	D	NA
omium VI	0.005	a	L	NA	500	NA	NA	NA	NA	NA		42	a	A	lung
per	0.0371	b	NA	NA	NA	NA	NA	NA	NA	NA		NA		D	NA
d	NA		NA	NA	NA	NA	NA	NA	NA	NA		NA		B2	various
cury	0.0003	a	M	hand tremor and memory disturbances	30	NA	NA	NA	NA	NA		NA		D	NA
l Aroclor-1260 (soil)	NA		NA	NA	NA	NA	NA	NA	NA	2	a	NA		B2	hepatocellular carcinoma
l Aroclor-1260 (water)	NA		NA	NA	NA	NA	NA	NA	NA	0.4	a	NA		B2	hepatocellular carcinoma

s:

= Integrated Risk Information System (IRIS)
= Health Effects Assessment Summary Tables (HEAST)
= Withdrawn from IRIS/HEAST
= Not applicable or not available
= High confidence
= Low confidence
= Medium confidence

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS, the classification is based on limited evidence from occupational epidemiologic studies consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1.

Chromium exists in two stable, natural forms: trivalent (III) and hexavalent (VI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS, 1995). Oral RfD values for both forms of chromium are 1.0 and

5E-03 (mg/kg-day). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a SFo of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

Copper is a nutritionally essential element, necessary for many of the body's enzymes. In the past, lead pipes and solder were used for residential water pipes, and resulting lead concentrations in drinking water exceeded USEPA guidelines. Copper has been used to replace water pipes in residences due to its lower toxicity to man. Short-term exposure to copper can result in anemia (the lack of iron), the breakdown of red blood cells, and liver and kidney lesions. The target organs for copper are the liver, kidney, and red blood cell. Vitamin C reduces copper uptake from the gut, and other substances can also influence copper uptake. Copper fumes can cause metal fume fever (Klaassen et al., 1986). As listed in IRIS, the D classification is based on no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data. The USEPA RfD is 0.0371 mg/kg-day, which is 2.6 mg/day for the average adult (70 kg). In typical vitamin supplements, 2 mg/day is the approximate dose (NRC, 1989).

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS, the classification is base on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

Mercury occurs in three forms: elemental, organic, and inorganic. The major source of this element is the degassing of the earth's crust. Target organs of inorganic mercury include the kidney, nervous system, fetus, and neonate. In other words, this inorganic can be toxic to a fetus if the mother is exposed during pregnancy. Mercury is toxic to all cells in the body — it binds to enzymes in the cells and disrupts their function, usually causing the cell to be useless or die. Because this inorganic is concentrated in the kidney prior to excretion, the kidney is a major target organ for mercury ingestion. The primary target of mercury vapor is the brain. Some forms of mercury are drawn towards fats in the body (such as the nervous system), where the form is changed into its toxic form. This causes the nervous disorder known as Minimata disease, overexposure to mercury through ingestion of contaminated fish. The fish ingested inorganic mercury from an industrial discharge, and the inorganic form was metabolized to organic mercury. USEPA set mercury's RfD to 0.0003 mg/kg-day (inorganic form). Mercury is liquid at room temperature, and is poorly absorbed in this form if ingested. Typical daily exposure is less than 1 μg/L-day (Klaassen, et al., 1986) (Dreisbach, et al., 1987).

Benzo(a)pyrene equivalents include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg)-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

PCB Aroclors are a group of chlorinated hydrocarbons (such as ***Aroclors-1248, 1254, and 1260***) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen, et al., 1986; Dreisbach, et al., 1987). USEPA classified PCB Aroclors as group B2 probable human carcinogens, primarily based on animal data. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. The cancer potency of PCB mixtures is determined using a tiered approach. The high risk and persistence tier uses an upper-bound slope factor of 2.0 $(mg/kg\text{-}day)^{-1}$ and is appropriate for food chain exposures, sediment and soil ingestion, dust or aerosol inhalation, and dermal exposure. The low risk and persistence tier uses an upper-bound slope factor of 0.4 $(mg/kg\text{-}day)^{-1}$ and is appropriate for ingestion of water soluble congeners and inhalation of evaporated congeners. The lowest risk and persistence tier uses an upper-bound slope factor of 0.07 $(mg/kg\text{-}day)^{-1}$ and is appropriate for PCB congener mixtures with congeners having more than four chlorines comprising less than 1/2% of the mixture.

10.6.5.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was computed separately to address child and adult exposure. Tables 10.6.12 and 10.6.13 present the computed HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 611 surface soils is 4E-04. The dermal pathway ILCR is 6E-05. Arsenic was the primary contributor to ILCR projections for the ingestion and dermal pathways. Benzo(a)pyrene equivalents and Aroclor-1260 were secondary contributors.

Table 10.6.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganics							
Arsenic (As)	0.0003	1.5	0.66	6.2	3.4E-04	0.24	3.8E-05
Cadmium (Cd)	0.001	NA	0.0067	0.063	ND	0.0024	ND
Chromium (Cr)	0.005	NA	0.017	0.16	ND	0.0060	ND
Copper (Cu)	0.04	NA	0.026	0.24	ND	0.0091	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Mercury (Hg)	0.0003	NA	0.076	0.71	ND	0.027	ND
Semivolatile Organics							
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	4.9E-05	ND	5.5E-06
PCBs							
Aroclor-1260	NA	2	ND	ND	1.2E-06	ND	1.3E-07
SUM Hazard Index/ILCR			0.8	7	4E-04	0.3	4E-05

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime Cancer Risk

Table 10.6.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganics								
Arsenic (As)	0.2	6E-05	7.5	0.14	0.45	3.8E-05	0.097	1.6E-05
Cadmium (Cd)	0.2	0.0002	NA	0.0014	0.0045	ND	0.00098	ND
Chromium (Cr)	0.2	0.001	NA	0.0034	0.011	ND	0.0025	ND
Copper (Cu)	0.2	0.008	NA	0.0052	0.017	ND	0.0037	ND
Lead (Pb)	0.2	NA	NA	ND	ND	ND	ND	ND
Mercury (Hg)	0.2	6E-05	NA	0.016	0.052	ND	0.011	ND
Semivolatile Organics								
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	2.2E-05	ND	9.0E-06
PCBs								
Aroclor-1260	0.5	NA	4	ND	ND	5.2E-07	ND	2.1E-07
SUM Hazard Index/ILCR				0.2	0.5	6E-05	0.1	2E-05

NOTES:

NA	Not available
ND	Not Determined due to lack of available information
lwa	Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR	Incremental Lifetime Cancer Risk
-	Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

The computed hazard indices for the adult resident were 0.8 for the soil ingestion pathway and 0.2 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 7 and 0.5, respectively. Arsenic was the primary contributor to HI projections for the ingestion and dermal pathways. Cadmium, chromium, copper, and mercury were secondary contributors.

Hypothetical Site Workers

Site worker ILCRs are 4E-05 for the ingestion pathway and 2E-05 for the dermal contact pathway. Arsenic was the primary contributor to ILCR projections, while benzo(a)pyrene equivalents and Aroclor-1260 were secondary contributors.

HIs for the ingestion and dermal pathways were projected to be 0.3 and 0.1 for the hypothetical site worker scenario, respectively. Arsenic was the primary contributor to HI projections for the ingestion and dermal pathways. Cadmium, chromium, copper, and mercury were secondary contributors.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a HI threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.6.14 presents the COCs identified for AOC 611 surface soil.

Future Site Residents

Arsenic, BEQs and Aroclor-1260 were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections.

Arsenic, chromium, copper, and mercury were identified as soil pathway COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

Arsenic and BEQs were identified as soil pathway COCs based on their contribution to cumulative industrial ILCR projections.

No hazard-based COCs were identified for the site worker scenario at AOC 611.

The extent of the COCs identified in surface soil is briefly discussed below. Residential soil RBCs and background concentrations were compared to each reported COC concentration.

Arsenic exceeded its RBC (0.43 mg/kg) in all seven surface soil samples; however, arsenic only exceeded its background value (19.9 mg/kg) in one surface soil sample (611SB002) with a concentration of 145 mg/kg. BEQs exceeded their RBC (88 μg/kg) in three of seven surface soil samples. Chromium exceeded its RBC (39 mg/kg) and its background value (34.8 mg/kg) in one of seven surface soil samples (611SB005) with a concentration of 61.4 mg/kg. Copper exceeded its RBC (310 mg/kg) in one of seven surface soil samples (611SB002) with a concentration of 746 mg/kg. Copper also exceed its background value (48.2 mg/kg) in two additional surface soil

T:' 5.14
S. .y of Risk and Hazard-based COCs
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Inorganics**						
		Arsenic (As)	0.66	6.2	3.4E-04	0.24	3.8E-05	1 2 4
		Cadmium (Cd)	0.0067	0.063	ND	0.0024	ND	
		Chromium (Cr)	0.017	0.16	ND	0.0060	ND	1
		Copper (Cu)	0.026	0.24	ND	0.0091	ND	1
		Lead (Pb)	ND	ND	ND	ND	ND	
		Mercury (Hg)	0.076	0.71	ND	0.027	ND	1
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	4.9E-05	ND	5.5E-06	2 4
		PCBs						
		Aroclor-1260	ND	ND	1.2E-06	ND	1.3E-07	2
	Dermal	**Inorganics**						
		Arsenic (As)	0.14	0.45	3.8E-05	0.097	1.6E-05	1 2 4
		Cadmium (Cd)	0.0014	0.0045	ND	0.00098	ND	
		Chromium (Cr)	0.0034	0.011	ND	0.0025	ND	
		Copper (Cu)	0.0052	0.017	ND	0.0037	ND	
		Lead (Pb)	ND	ND	ND	ND	ND	
		Mercury (Hg)	0.016	0.052	ND	0.011	ND	
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	2.2E-05	ND	9.0E-06	2 4
		PCBs						
		Aroclor-1260	ND	ND	5.2E-07	ND	2.1E-07	
Surface Soil Pathway Sum			0.9	8	5E-04	0.4	7E-05	

Notes:

ND indicates not determined due to the lack of available risk information.

ILCR indicates incremental excess lifetime cancer risk

HI indicates hazard index

1- Chemical is a COC by virtue of projected child residence noncarcinogenic hazard.

2- Chemical is a COC by virtue of projected future resident lifetime ILCR.

3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.

4- Chemical is a COC by virtue of projected site worker ILCR.

samples (611SB006 and 611SB007). Mercury exceeded its RBC (2.3 mg/kg) in two of seven surface soil samples (611SB001 and 611SB002). Mercury also exceeded its background value (0.62 mg/kg) in three additional surface soil samples (611SB005, 611SB006, and 611SB007). Aroclor-1260 exceeded its RBC (320 μg/kg) in the single duplicate surface soil sample analyzed for PCBs (611SB007) with a concentration of 370 μg/kg.

Lead

Lead exceeded its residential screening value (400 mg/kg) in two of seven surface soil samples (611SB002 and 611SB007), and exceeded its background value (180 mg/kg) in one additional surface soil sample (611SB006). Since neither a RfD nor a SF has been determined for lead by USEPA, it cannot be quantified in the risk assessment. However, AOC 611 is relatively small in area, and the mean lead concentration for the site is 201 mg/kg, which is below its residential screening value. Sample designations 611SB002, 611SB006, and 611SB007 are in the northeast portion of AOC 611. The mean lead concentration from 611SB002, 611SB006, and 611SB007 is 425 mg/kg, which slightly exceeds the residential screening value for lead.

10.6.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone F. If this area were used as a residential site, the surface coverings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current and future site workers and future site residents.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentrations were used as the EPCs for this site. Use of maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely for the maximum detected concentration to be representative of all soil constituents throughout the site. However, the lack of delineation leaves the possibility that the maximum detected concentration does not equal the maximum present concentration; therefore underestimating actual concentrations.

Frequency of Detection and Spatial Distribution

BEQs were detected in four of seven surface soil samples. Aroclor-1260 was detected in the single duplicate surface soil sample analyzed for PCBs. Arsenic, chromium, copper, and lead were detected in all seven surface soil samples. Cadmium was detected in four of seven surface soil samples, and mercury was detected in six of seven surface soil samples. Because inorganic COCs at AOC 611 were detected in nearly all surface soil samples, this would indicate either a source of contamination exists onsite (detected concentrations predominantly greater than background values), and/or that concentrations are representative of ambient conditions (detected concentrations predominantly less than background values).

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

A conservative screening process was used to identify COPCs for AOC 611. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, manganese was reported at a concentration close to the RBC (e.g. within 10% of their RBCs). Aluminum and beryllium were detected at maximum concentrations exceeding their corresponding RBCs and were eliminated based on comparison to their corresponding reference concentrations. Wilcoxon rank sum test analysis also indicated that site concentrations of these inorganics were within background concentrations.

Background-Related Risk

Aluminum and beryllium were detected in AOC 611 surface soil above their RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of these elements.

The maximum surface soil concentrations of aluminum (14,300 mg/kg) and beryllium (0.49 mg/kg) for AOC 611 equate with hazard quotients of 0.2 and 0.001, respectively, for the residential child scenario, and 0.01 and 0.00007, respectively, for the site worker scenario. The maximum surface soil concentration of beryllium also equates with an ILCR of 4E-06 for the residential scenario and 5E-07 for the site worker scenario; however the Zone F background surface soil concentrations beryllium (1.05 mg/kg) equates with an ILCR of 8E-06.

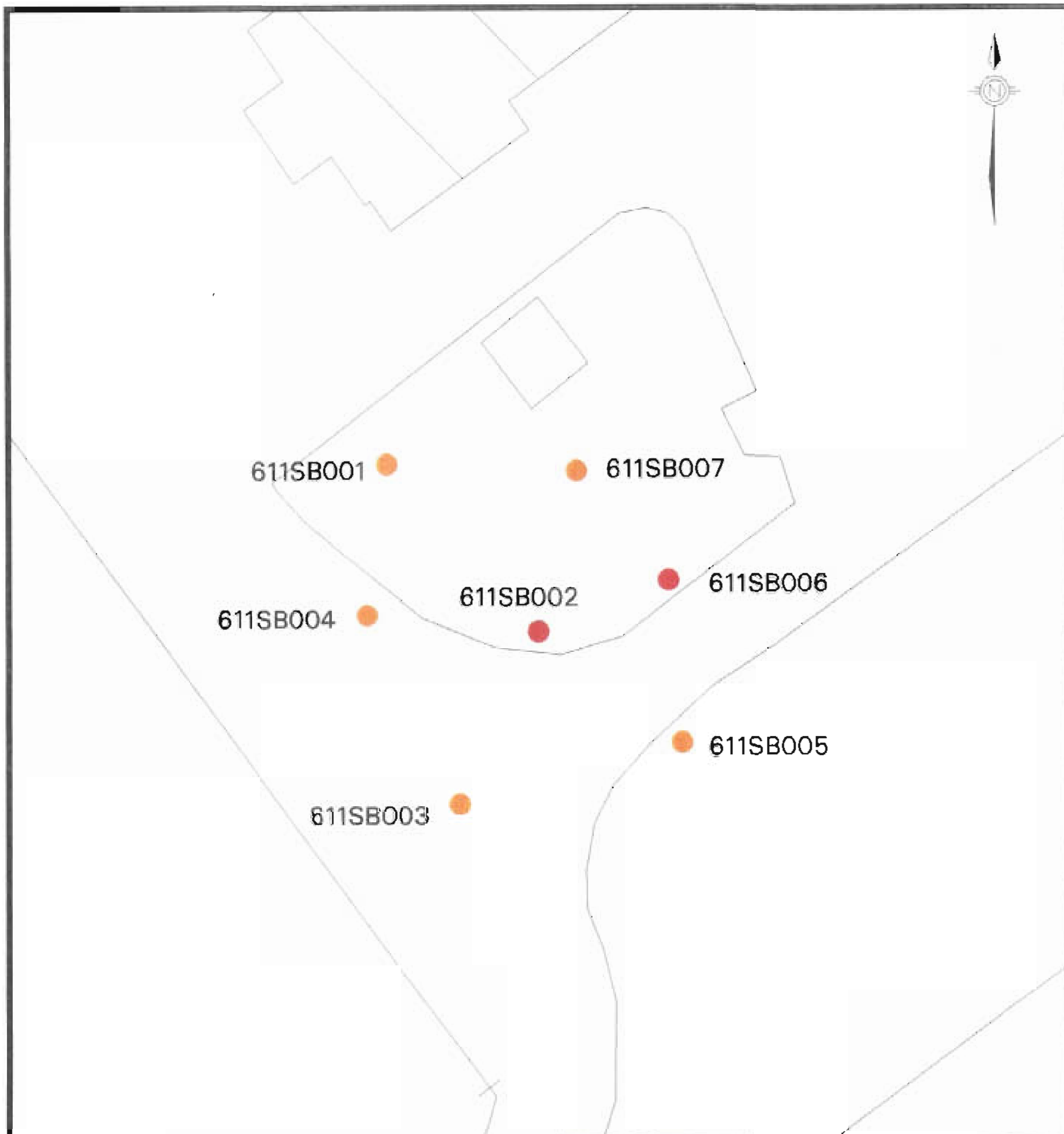
10.6.5.7 Risk Summary

The risk and hazard posed by contaminants at AOC 611 were assessed for the future site worker and the future site resident under RME assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.6.15 presents the risk summary for each soil pathway/receptor group evaluated for AOC 611.

Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 611 are arsenic, BEQs, chromium, copper, mercury, and Aroclor-1260. Figure 10.6-12 illustrates point risk estimates for AOC 611 based on soil exposure pathways under a future residential scenario. Table 10.6.16 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Arsenic is the primary contributor to risk estimates above 1E-06 at six of seven surface soil sample locations, and a secondary contributor at one surface soil sample location (611SB006). BEQs were the primary contributors to risk at 611SB006, and secondary contributors to risk at three other surface soil sample locations (611SB002, 611SB005, and 611SB007). Aroclor-1260 was also a secondary contributor to the risk estimate at 611SB007. Risk estimates ranged from 1E-05 (611SB003) to 4E-04 (611SB002). The mean risk estimate is 8E-05.



LEGEND
- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 80

ZONE F - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6.12
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 611

Table 10.6.15
Summary of Risk and Hazard
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.8	7	4E-04	0.3	4E-05
	Dermal Contact	0.2	0.5	6E-05	0.1	2E-05
Sum of Soil Pathways		0.9	8	5E-04	0.4	7E-05

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

Table 10.6.16
Point Estimates of Risk and Hazard - Soil Pathways
Residential Scenario
AOC 611
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
611	001	Arsenic (As)	7.9	MG/KG	0.3611	68.31	20.6348	100.00
611	001	B(a)P Equiv.	ND	UG/KG	NA		NA	
611	001	Cadmium (Cd)	ND	MG/KG	NA		NA	
611	001	Chromium (Cr)	20.1	MG/KG	0.0551	10.43	NA	
611	001	Copper (Cu)	21.1	MG/KG	0.0072	1.37	NA	
611	001	Lead (Pb)	19.6	MG/KG	NA		NA	
611	001	Mercury (Hg)	2.3	MG/KG	0.1051	19.89	NA	
		Total			0.5286		20.6348	
611	002	Arsenic (As)	145	MG/KG	6.6276	84.90	378.7401	99.17
611	002	B(a)P Equiv.	191.15	UG/KG	NA		3.1655	0.83
611	002	Cadmium (Cd)	4.9	MG/KG	0.0671	0.86	NA	
611	002	Chromium (Cr)	33.9	MG/KG	0.0930	1.19	NA	
611	002	Copper (Cu)	746	MG/KG	0.2557	3.28	NA	
611	002	Lead (Pb)	400	MG/KG	NA		NA	
611	002	Mercury (Hg)	16.7	MG/KG	0.7633	9.78	NA	
		Total			7.8068		381.9056	
611	003	Arsenic (As)	5.3	MG/KG	0.2423	83.32	13.8436	100.00
611	003	B(a)P Equiv.	ND	UG/KG	NA		NA	
611	003	Cadmium (Cd)	ND	MG/KG	NA		NA	
611	003	Chromium (Cr)	17	MG/KG	0.0466	16.03	NA	
611	003	Copper (Cu)	5.5	MG/KG	0.0019	0.65	NA	
611	003	Lead (Pb)	22.9	MG/KG	NA		NA	
611	003	Mercury (Hg)	ND	MG/KG	NA		NA	
		Total			0.2908		13.8436	
611	004	Arsenic (As)	5.9	MG/KG	0.2697	85.94	15.4108	100.00
611	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
611	004	Cadmium (Cd)	ND	MG/KG	NA		NA	
611	004	Chromium (Cr)	14.8	MG/KG	0.0406	12.94	NA	
611	004	Copper (Cu)	0.94	MG/KG	0.0003	0.10	NA	
611	004	Lead (Pb)	7.1	MG/KG	NA		NA	
611	004	Mercury (Hg)	0.07	MG/KG	0.0032	1.02	NA	
		Total			0.3138		15.4108	
611	005	Arsenic (As)	7.2	MG/KG	0.3291	56.04	18.8064	99.57
611	005	B(a)P Equiv.	4.945	UG/KG	NA		0.0819	0.43
611	005	Cadmium (Cd)	0.24	MG/KG	0.0033	0.56	NA	

Table 10.6.16
Point Estimates of Risk and Hazard - Soil Pathways
Residential Scenario
AOC 611
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
611	005	Chromium (Cr)	61.4	MG/KG	0.1684	28.67	NA	
611	005	Copper (Cu)	38.9	MG/KG	0.0133	2.27	NA	
611	005	Lead (Pb)	84.8	MG/KG	NA		NA	
611	005	Mercury (Hg)	1.6	MG/KG	0.0731	12.45	NA	
		Total			0.5872		18.8883	
611	006	Arsenic (As)	11.5	MG/KG	0.5256	72.03	30.0380	29.58
611	006	B(a)P Equiv.	4317.6	UG/KG	NA		71.5008	70.42
611	006	Cadmium (Cd)	0.92	MG/KG	0.0126	1.73	NA	
611	006	Chromium (Cr)	23.4	MG/KG	0.0642	8.79	NA	
611	006	Copper (Cu)	78.2	MG/KG	0.0268	3.67	NA	
611	006	Lead (Pb)	309	MG/KG	NA		NA	
611	006	Mercury (Hg)	2.2	MG/KG	0.1006	13.78	NA	
		Total			0.7298		101.5388	
611	007	Aroclor-1260	370	UG/KG	NA		1.6787	4.66
611	007	Arsenic (As)	12.55	MG/KG	0.5736	77.58	32.7806	91.05
611	007	B(a)P Equiv.	93.196	UG/KG	NA		1.5434	4.29
611	007	Cadmium (Cd)	1.45	MG/KG	0.0199	2.69	NA	
611	007	Chromium (Cr)	20.5	MG/KG	0.0562	7.60	NA	
611	007	Copper (Cu)	54.95	MG/KG	0.0188	2.55	NA	
611	007	Lead (Pb)	566.5	MG/KG	NA		NA	
611	007	Mercury (Hg)	1.55	MG/KG	0.0708	9.58	NA	
		Total			0.7394		36.0027	

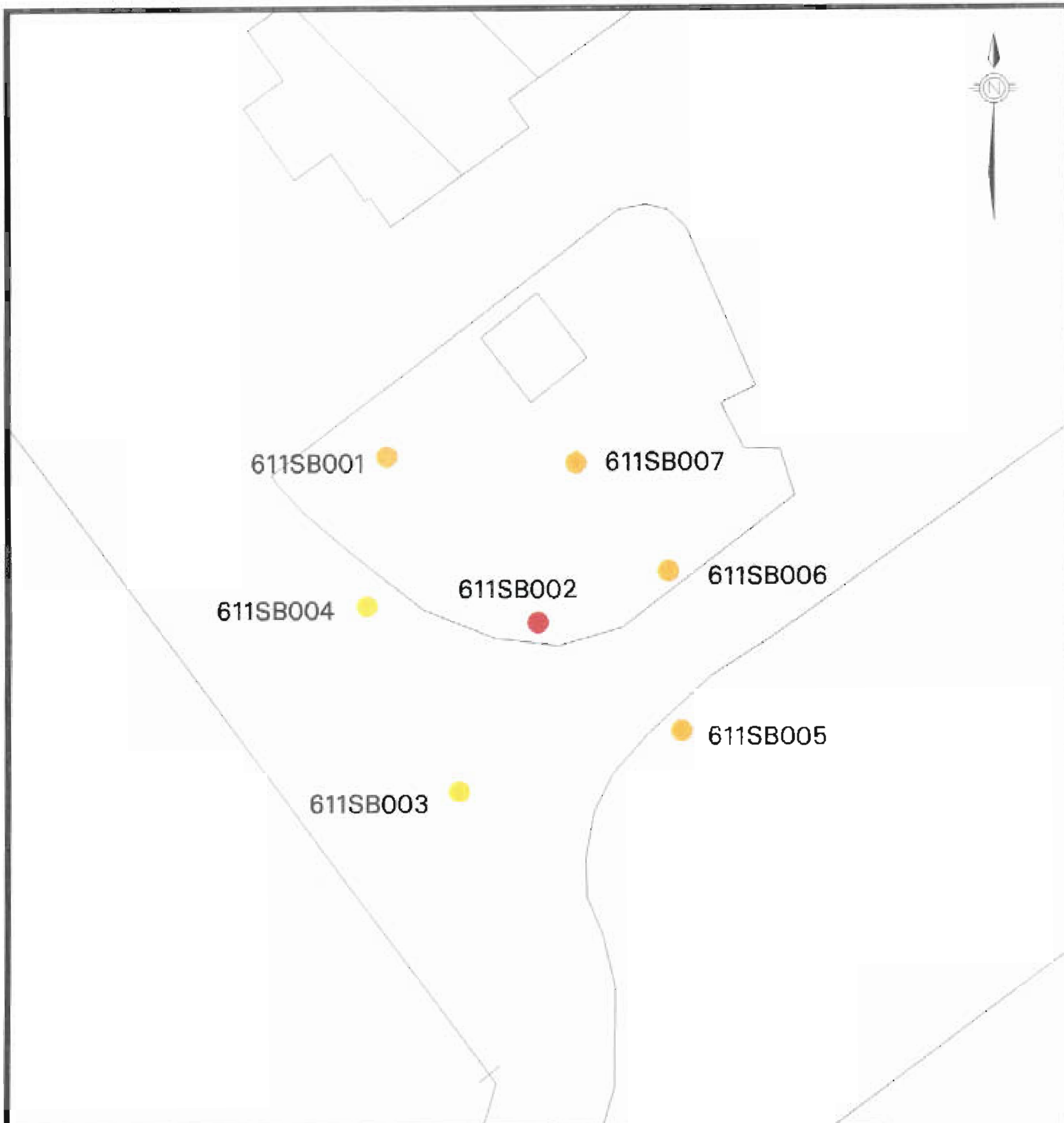
Figure 10.6-13 illustrates point estimates for hazard at AOC 611 based on soil exposure pathways under a future residential scenario. Arsenic was the primary contributor to hazard estimates at all seven surface soil sample locations; however, only one surface soil sample produced a HI above unity (611SB002). Secondary contributors consisted of cadmium, chromium, copper, and mercury. HI estimates ranged from 0.3 (611SB003) to 8 (611SB002). The mean hazard estimate is 2.

Soil — Site Worker Scenario

Arsenic and BEQs were identified as COCs for the industrial surface soil pathway. Figure 10.6 14 illustrates point risk estimates for AOC 611 based on soil exposure pathways under a future industrial scenario. Table 10.6.17 summarizes the risk and hazard contribution of each COC at each sample location.

Arsenic was the primary contributor to risk estimates above 1E-06 for six of seven surface soil sample locations in the industrial scenario at AOC 611, and a secondary contributor at one surface soil sample location (611SB006). BEQs were primary contributors to risk at 611SB006, and secondary contributors at 611SB002, 611SB005, and 611SB007. Risk estimates ranged from 2E-06 (611SB003) to 5E-05 (611SB002). The mean risk estimate is 6E-06.

Arsenic was the sole contributor to hazard estimates at AOC 611 for the industrial scenario, although HI did not exceed unity at any surface soil sample location. Hazard estimates ranged from 0.01 (611SB003) to 0.3 (611SB002). The mean hazard estimate is 0.06.



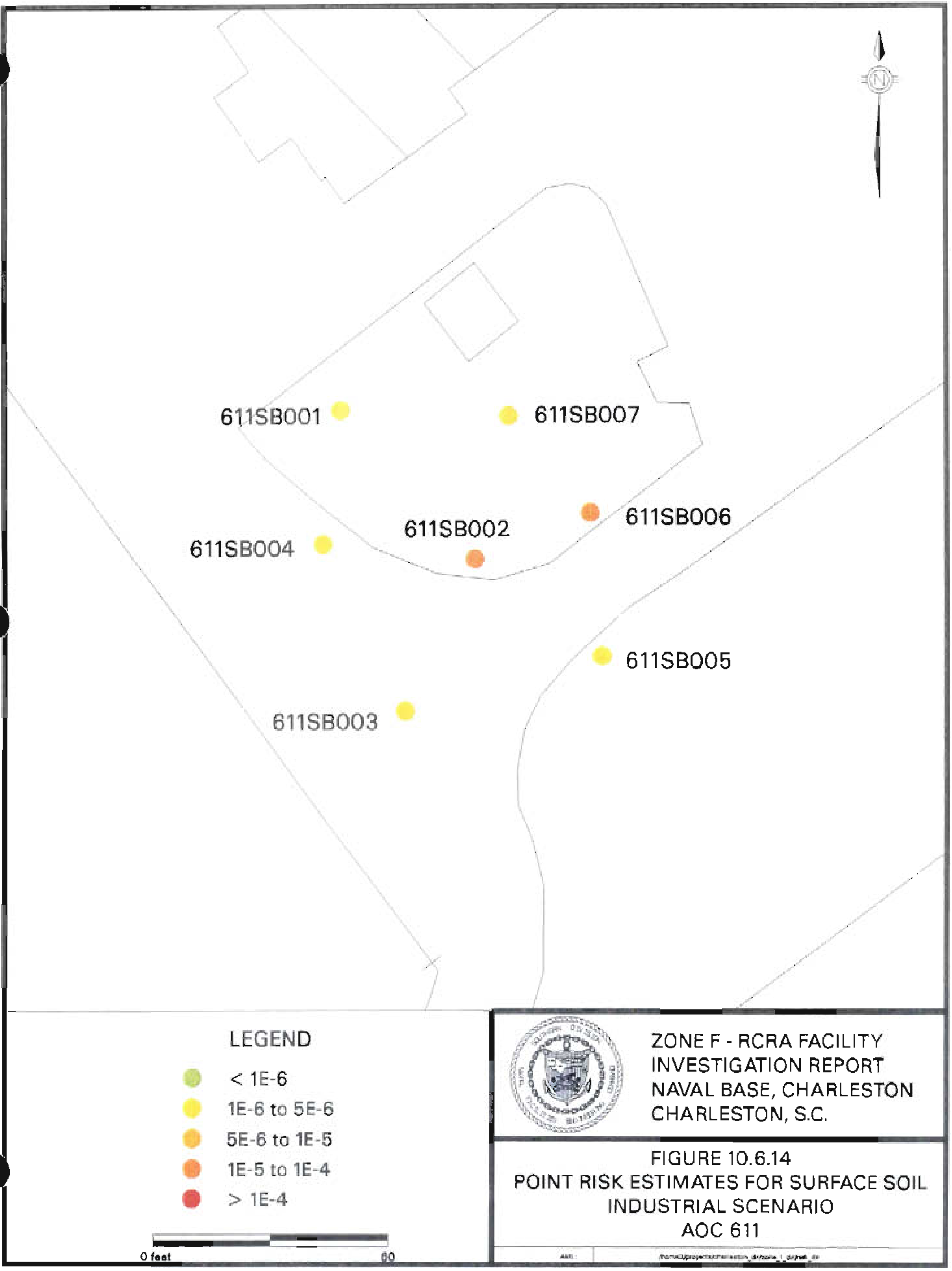
LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 60

ZONE F - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6.13
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 611



ZONE F - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6.14
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
AOC 611

Table 10.6.17
Point Estimates of Risk and Hazard - Soil Pathways
Industrial Scenario
AOC 611
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
611	001	Arsenic (As)	7.9	MG/KG	0.0182	100	2.9191	100
611	001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0182		2.9191	
611	002	Arsenic (As)	145	MG/KG	0.3334	100	53.5785	98.81
611	002	B(a)P Equiv.	191.15	UG/KG	NA		0.6436	1.19
		Total			0.3334		54.2221	
611	003	Arsenic (As)	5.3	MG/KG	0.0122	100	1.9584	100
611	003	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0122		1.9584	
611	004	Arsenic (As)	5.9	MG/KG	0.0136	100	2.1801	100
611	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0136		2.1801	
611	005	Arsenic (As)	7.2	MG/KG	0.0166	100	2.6605	99.38
611	005	B(a)P Equiv.	4.945	UG/KG	NA		0.0167	0.62
		Total			0.0166		2.6771	
611	006	Arsenic (As)	11.5	MG/KG	0.0264	100	4.2493	22.62
611	006	B(a)P Equiv.	4317.6	UG/KG	NA		14.5380	77.38
		Total			0.0264		18.7873	
611	007	Arsenic (As)	12.55	MG/KG	0.0289	100	4.6373	93.66
611	007	B(a)P Equiv.	93.196	UG/KG	NA		0.3138	6.34
		Total			0.0289		4.9511	

10.6.5.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident or site worker as presented in Table 10.6.18 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.

10.6.6 Corrective Measures Considerations

For AOC 611, the upper and lower soil intervals were investigated. A total of 14 soil samples from seven boring locations were collected from the upper and lower intervals. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use.

BEQs, Aroclor-1260, arsenic, chromium, copper, lead, and mercury were identified as COCs in the upper soil interval. The soil pathway cumulative residential exposure risk is 5E-04 and the cumulative HI is 8 (resident child). The cumulative residential exposure risk is above USEPA's acceptable highest risk level of 1E-04. The HI is greater than USEPA's acceptable HI of 1.

Lead was detected in all seven surface soil samples collected at AOC 611. Soil concentrations ranged from 7.1 to 566.5 mg/kg. Only two of seven samples exceeded the residential cleanup level of 400 mg/kg, 611SB007 and 611SB002.

Residential risk-based RGOs for surface soil for arsenic and BEQs are 0.38 and 0.06 mg/kg, respectively, based on a target risk of 1E-06. Hazard-based RGOs for surface soil for chromium, copper, and mercury are 365, 2,917, and 22 mg/kg, respectively, based on a target HI of 1.

Table 10.6.18
Remedial Goal Options for Soil
AOC 611
Naval Base Charleston, Zone F
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Inorganic										
Arsenic (As)	1.5	0.0003	145.0	66	22	2.2	0.38	3.8	38	19.9
Chromium (Cr)	NA	0.005	61.4	1094	365	36	NA	NA	NA	34.8
Copper (Cu)	NA	0.04	746.0	8751	2917	292	NA	NA	NA	48.2
Mercury (Hg)	NA	0.0003	16.7	66	22	2.2	NA	NA	NA	0.62
Semivolatile Organics										
Benzo(a)pyrene equivalents	7.3	NA	4.3	NA	NA	NA	0.060	0.60	6	NA
PCBs										
Aroclor-1260	2	NA	0.4	NA	NA	NA	0.220	2.20	22	NA

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Inorganic										
Arsenic (As)	1.5	0.0003	145.0	1305	435	43	2.7	27	271	19.9
Semivolatile Organics										
Benzo(a)pyrene equivalents	7.3	NA	4.3	NA	NA	NA	0.30	3.0	30	NA

NOTES:

EPC — Exposure point concentration
NA — Not applicable
\- — Remedial goal options were based on the residential or site worker lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.6.19. Corrective measures are described in Section 9.

Table 10.6.19
Potential Corrective Measures for AOC 611

Medium	Compounds of Concern	Potential Corrective Measures
Soil	Arsenic, chromium, copper, lead, mercury, and Aroclor-1260 BEQs	a) No Action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment

10.7 AOC 613, Old Locomotive Repair Shop, Former Building 1169; AOC 615, Old Chain Locker, Building 1391 and SWMU 175, Crane Painting Area, Near Building 1277

Though the approved final RFI work plan called for a separate investigation for SWMU 175, these sites were combined into one investigation due to their close proximity and their potential for similar COPCs.

AOC 613 (a RFI site) is located at the former Building 1169, a former locomotive and crane repair facility which operated from the 1930s until 1985, when the building was demolished. Maintenance activities included changing oil, repairing hydraulic systems and equipment overhaul. Materials released, stored, or disposed of at the site included oil, grease, diesel fuel, and cleaning solvents. Numerous spills were reported, some to the storm water drainage system. In addition, a UST at the site alledgedly contained waste oil and other waste liquids. Documentation of an apparent removal of this UST was unavailable. Building 242, built in 1987, occupies a portion of the site area.

AOC 615 (a CSI site) is the site of the former Building 1391, the former chain locker. Operated from 1970 to 1977, the site was used to store and service anchor chain. Materials released, stored, or disposed of at the site included epoxies and resins. These materials were stored in large tanks onsite, used for dipping anchor chain sections. Epoxy and resin wastes were reportedly stored in 55-gallon drums behind the building.

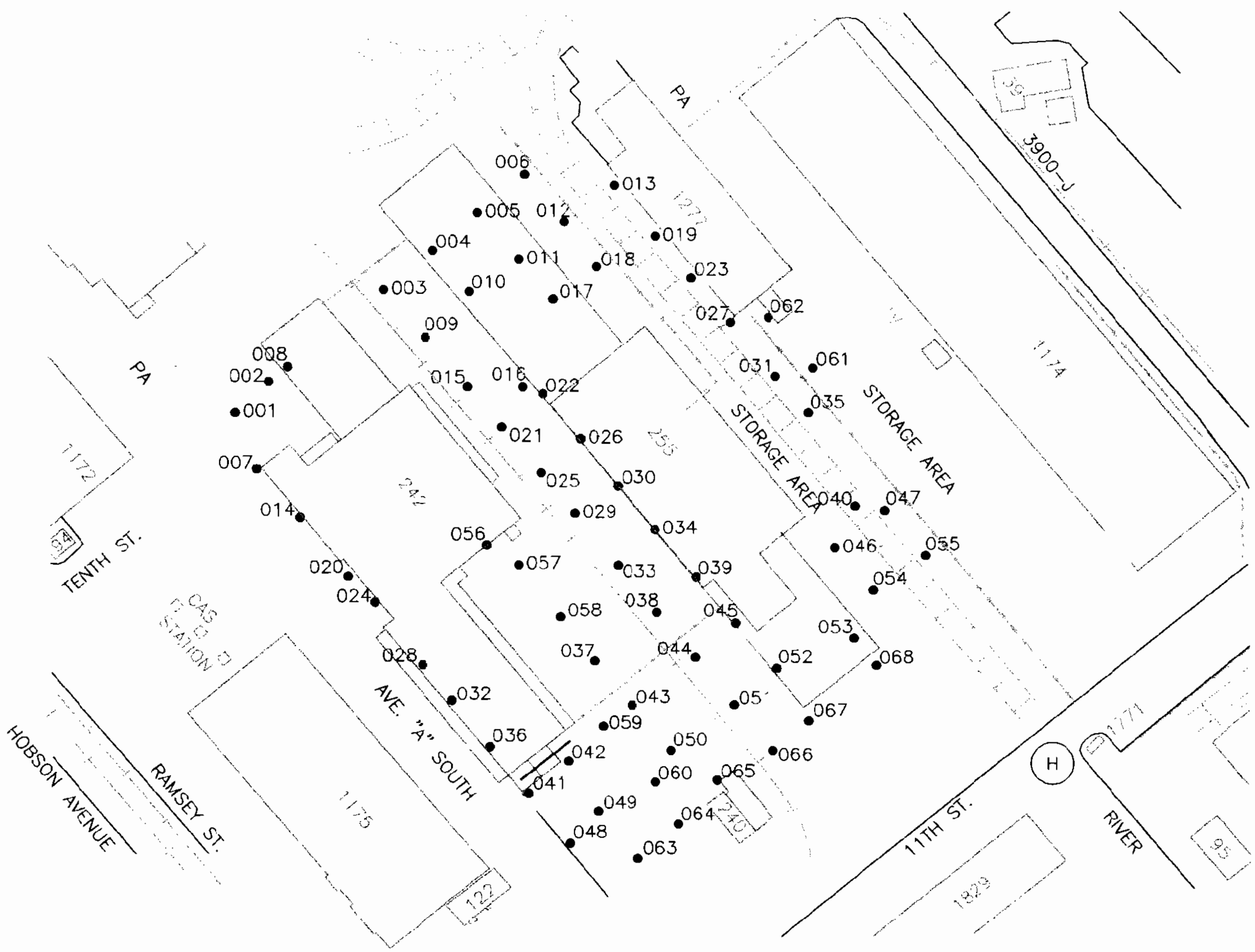
SWMU 175 (a RFI site) is the former crane painting area, situated south and west of Building 1277. The site was used until 1993. The site consists of crane tracks and a paved asphalt road. During previous site visits, visible evidence of former painting activities were noted. Though no spills or releases were documented at this site, a past release was thought probable. Materials released, stored, or disposed of at the site included blast media, paint constituents, heavy metals, lead, acetone, xylene, and toluene.

During 1996, the Commissioners of Public Works for the City of Charleston, SC, requested that GEL, Inc., conduct a pre-lease evaluation of baseline environmental conditions at a 10.1 acre area encompassing most of AOCs 613 and 615. This evaluation consisted of a modified Phase I environmental site assessment, a subsurface soil and groundwater investigation, asbestos and lead-based paint survey, and a facilities evaluation. The results of this investigation were reported in the *Evaluation of Baseline Environmental Conditions, Proposed CPW Lease Areas, Former Charleston Naval Shipyard, North Charleston, South Carolina* (GEL, Inc., August 8, 1996). The evaluation identified free petroleum product in a groundwater monitoring well between AOC 613 and SWMU 175 (GEL014), as well as other groundwater organic contamination within the area investigated. Additionally, several USTs within the area were recommended for removal/ abandonment, along with associated piping (GEL, Inc., August 8, 1996).

10.7.1 Site Geology and Hydrogeology

The DPT soil and groundwater sample locations associated with AOCs 613/615 and SWMU 175 are shown in Figure 10.7-1. Sediment and monitoring well locations associated with the investigation are shown in Figure 10.7-2.

Five monitoring well borings were used to characterize the stratigraphy at AOCs 613 and 615 and SWMU 175. The stratigraphy consists of fill, Quaternary clay, sand, and marsh clay overlying the Ashley Formation. The Quaternary clay and sand deposits extend to a depth of approximately 15 ft bgs. Figures 10.7-3 and 10.7-4 present cross sectional views of the stratigaphy at the combined site. The clay and sand samples exhibit an average grain size distribution of 7% sand, 37% silt, and 56% clay. The marsh clay deposits exhibit a grain size distribution of 7% sand, 48% silt, and 45% clay. The total depth reached by the monitoring well borings was 36.0 ft bgs (61302D). Boring logs are contained in Appendix A.



LEGEND

● – DPT LOCATION

NOTE:
NO SAMPLES WERE COLLECTED FROM 011, 015, OR 016.

100 0 100

SCALE IN FEET

ZONE F
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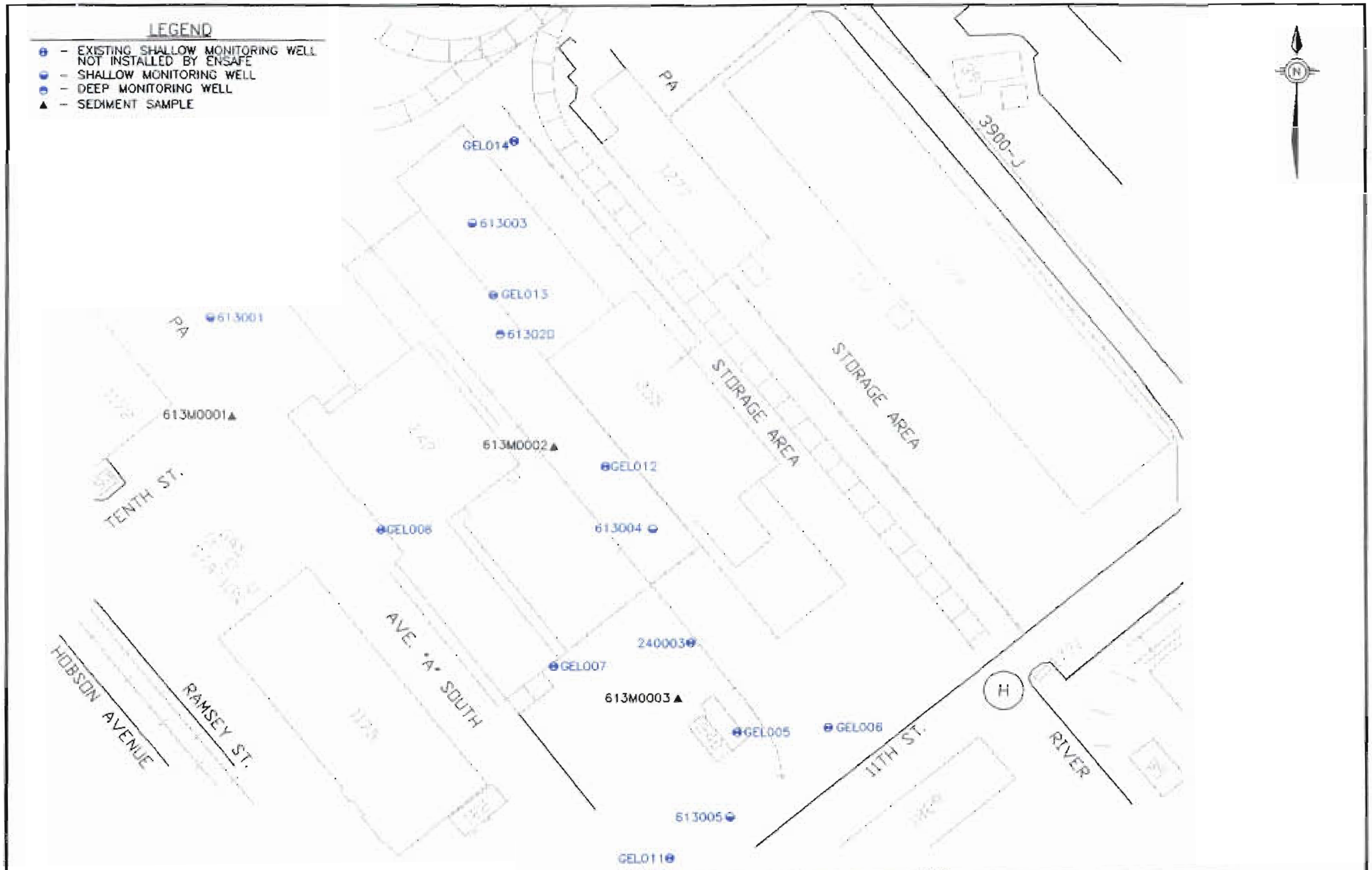
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7-1
DPT SCREENING LOCATIONS
AOC 613 & 615
AND SWMU 175

Date: 16 DEC 97

DWG Name: 29CF613B



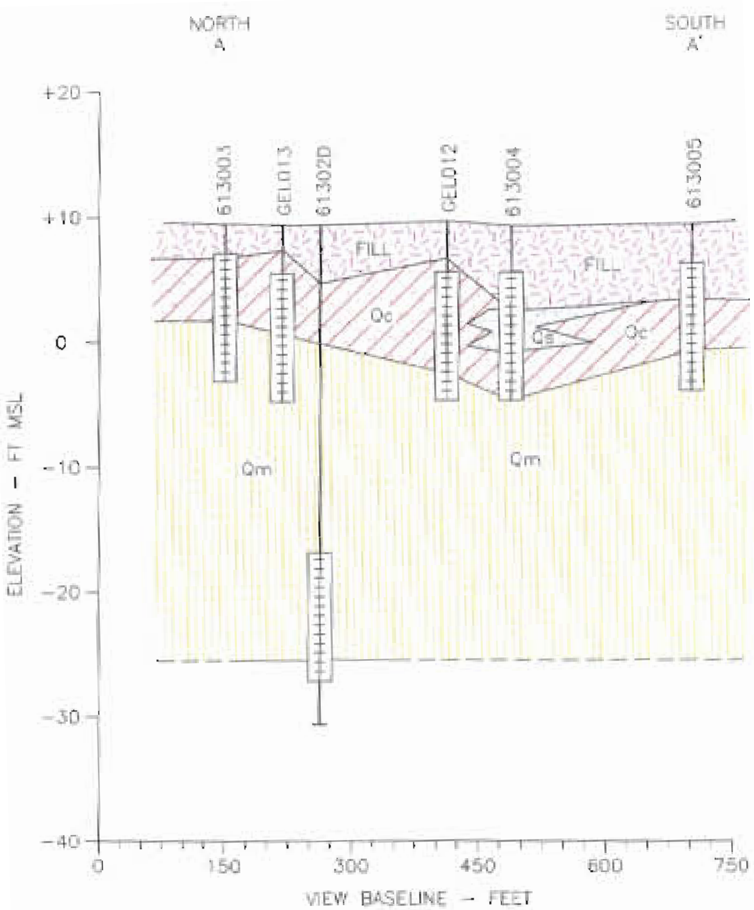
125 0 125

SCALE FEET

ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

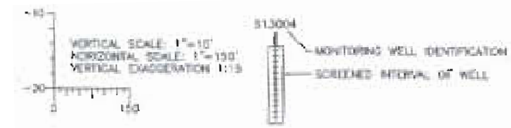
FIGURE 10.7-2
SEDIMENT AND
GROUNDWATER LOCATIONS
AOC 613/615 AND SWMU 175

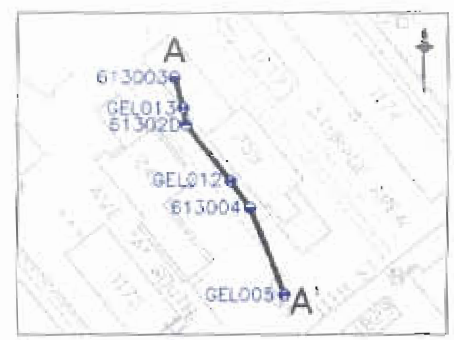
DWG DATE: 10/28/97 | DWG NAME: 29CF613A



LEGEND

FILL	Undifferentiated mixture of medium to high plasticity clays, fine sand, silt, gravel and ROC. Varies greatly with location.
Qc	QUATERNARY CLAYEY SAND AND SILTY SAND--brown, orange-brown, gray, green, and tan, very fine to fine sand often with trace medium grains, varying amounts of silt and inorganic gray clay, often interbedded with soft gray, medium plasticity clay laminae; sand occasionally unconsolidated and loose. AQUIFER
Qs	QUATERNARY SAND--undifferentiated olive-brown, gray, and orange sand; primarily very fine to fine and moderately to well-sorted but typically increases in grain size with depth (from fine to medium with some coarse); clean to silty sand. AQUIFER
Qm	QUATERNARY MARSH CLAY--dark gray to black, silty, high organic content, with brown grasses and occasional peat, very soft, low plasticity, sticky; occasionally interbedded with very fine to fine sand laminae and pods. AQUITARD.





ZONE F
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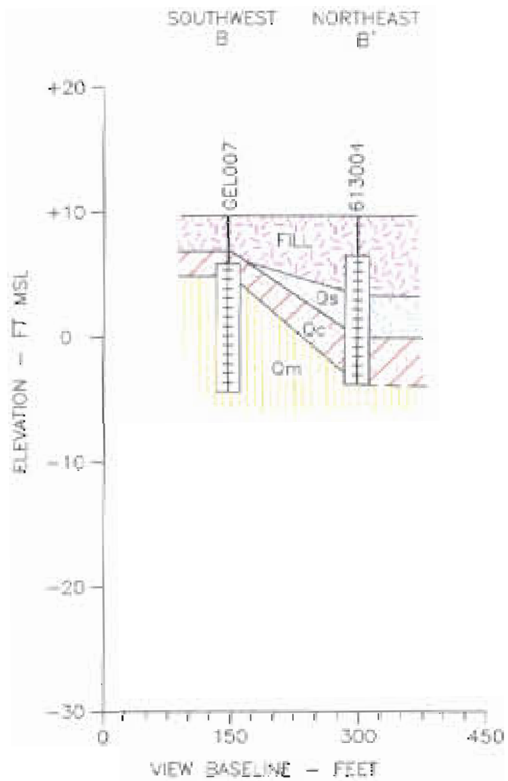
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

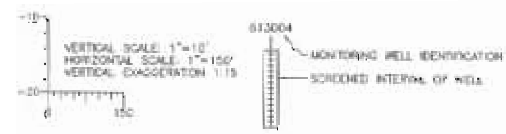
FIGURE 10.7-3
SWMU 175, AOCs 613 AND 615
LITHOLOGIC CROSS SECTION A-A'

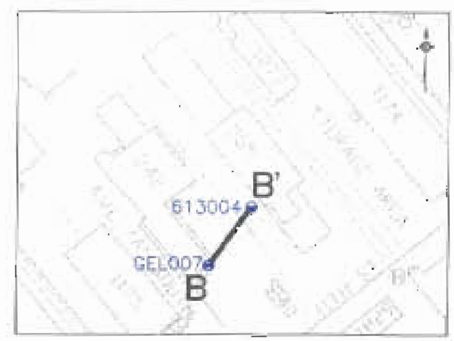
DWG DATE: 11/13/97 | DWG NAME: 2906CRAA



LEGEND

FILL	Undifferentiated mixture of medium to high plasticity clays, fine sand, silt, gravel and POC. Varies greatly with location
Qc	QUATERNARY CLAYEY SAND AND SILTY SAND--brown, orange-brown, gray, green, and tan, very fine to fine sand often with trace medium grains, varying amounts of silt and inorganic gray clay, often interbedded with soft gray, medium plasticity clay laminae; sand occasionally unconsolidated and loose. AQUIFER
Qs	QUATERNARY SAND--undifferentiated olive-brown, gray, and orange sand; primarily very fine to fine and moderately to well-sorted but typically increases in grain size with depth (from fine to medium with some coarse); clean to silty sand. AQUIFER
Qm	QUATERNARY MARSH CLAY--dark gray to black, silty, high organic content, with brown grasses and occasional peat, very soft, low plasticity, sticky; occasionally interbedded with very fine to fine sand laminae and pods. AQUITARD.





ZONE F
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FIGURE 10.7-4
SWMU 175, AOC 613 AND 615
LITHOLOGIC CROSS SECTION B-B'

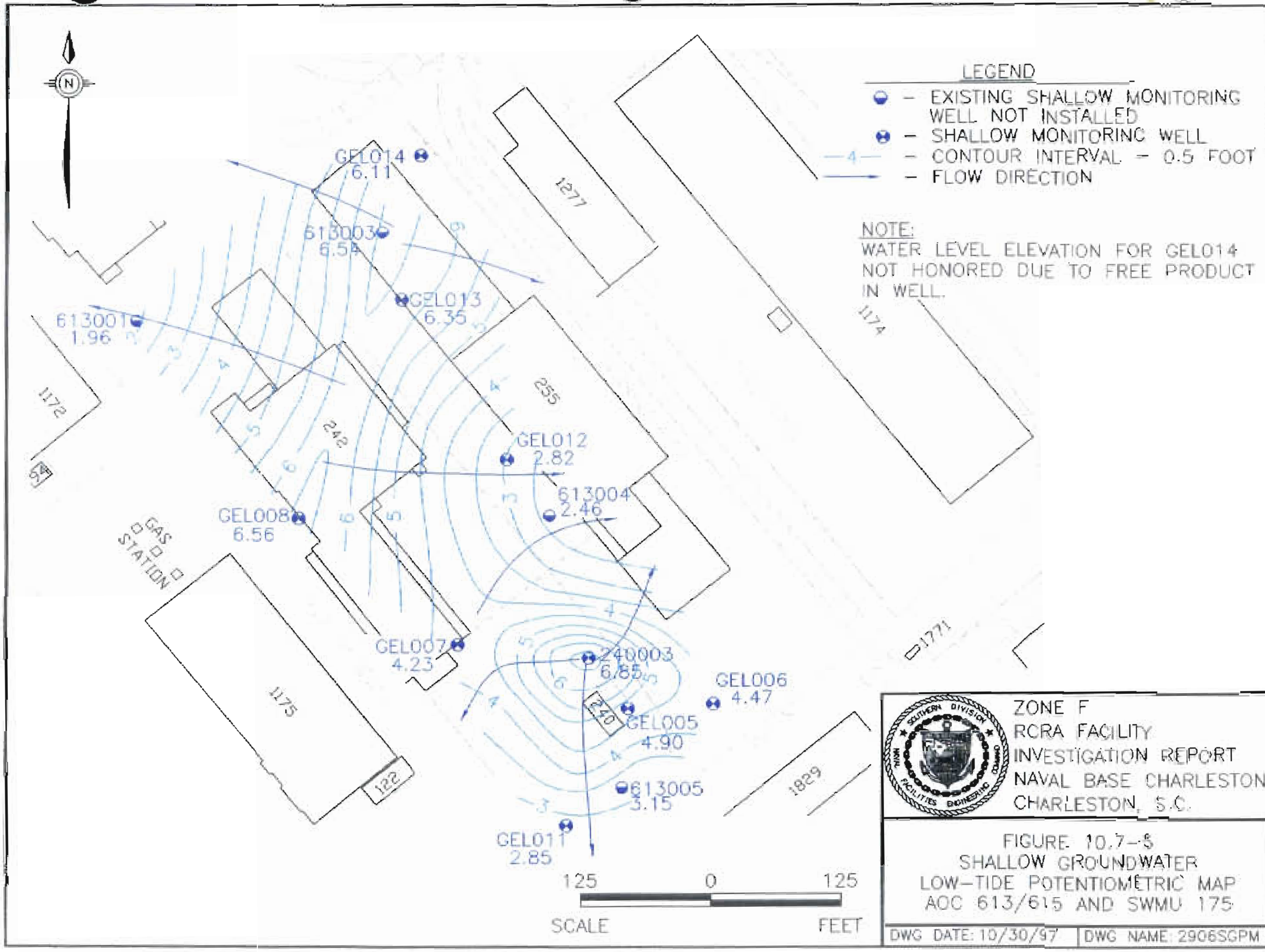
DWG DATE: 11/13/97 | DWG NAME: 2906CRBB

Figure 10.7-5 depicts the shallow groundwater potentiometric surface and inferred flow direction at low tide. Very little difference in the static water levels and the overall flow pattern at the combined AOCs 613/615 and SWMU 175 area were observed between high and low tide, therefore no high tide potentiometric map is provided. The mounding observed at well 240003 is most likely due to recharge caused by the absence of pavement in this area. The cause of the groundwater divide between wells GEL008 and 613003 is unknown. The hydraulic conductivity of the clay and sand deposits, calculated from slug testing, varied from 0.32 to 1.0 ft/day. The shallow horizontal hydraulic gradient, based on Figure 10.7-5 ranges from 2E-02 on the east side of the site to 2.4E-02 on the south side of the site. The horizontal flow velocity was calculated to range from 6.4E-03 ft/day to 2.4E-02 ft/day in the shallow clay and sand deposits.

Figures 10.7-6 and 10.7-7 depict the deep groundwater potentiometric surface at the site and inferred flow direction at low and high tides, respectively. A reversal of the overall flow pattern at the AOC was observed between high and low tide. This is most likely due to direct hydraulic connection with the Cooper River. The hydraulic conductivity of the marsh clay calculated from slug testing, was 0.12 ft/day. The horizontal hydraulic gradient, based on Figure 10.7-6 was 5.9E-04. The horizontal flow velocity was calculated at 7.1E-05 ft/day in the deep horizon. Comparisons of the vertical hydraulic gradients between wells GEL012 and 61302D at high and low tides revealed a very consistent downward flow potential of 0.143 and 0.140, respectively.

10.7.2 Field Investigation Approach

The objective of the field investigation at AOCs 613/615 and SWMU 175 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled during the RFI included soil, sediment and groundwater. Section 3 of this report


LEGEND
EXISTING SHALLOW MONITORING WELL NOT INSTALLED
SHALLOW MONITORING WELL
CONTOUR INTERVAL – 0.5 FOOT
FLOW DIRECTION
NOTE:
WATER LEVEL ELEVATION FOR GEL014 NOT HONORED DUE TO FREE PRODUCT IN WELL.
GEL014 6.11
613003 6.54
GEL013 6.35
613001 1.96
GEL012 2.82
613004 2.46
GEL008 6.56
GEL007 4.23
240003 6.85
GEL006 4.47
GEL005 4.90
613005 3.15
GEL011 2.85
GAS STATION
1277
1174
255
242
1172
1175
122
240
1829
1771
125 0 125
SCALE FEET
ZONE F
RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-5
SHALLOW GROUNDWATER LOW-TIDE POTENTIOMETRIC MAP
AOC 613/615 AND SWMU 175
DWG DATE: 10/30/97
DWG NAME: 2906SGPM

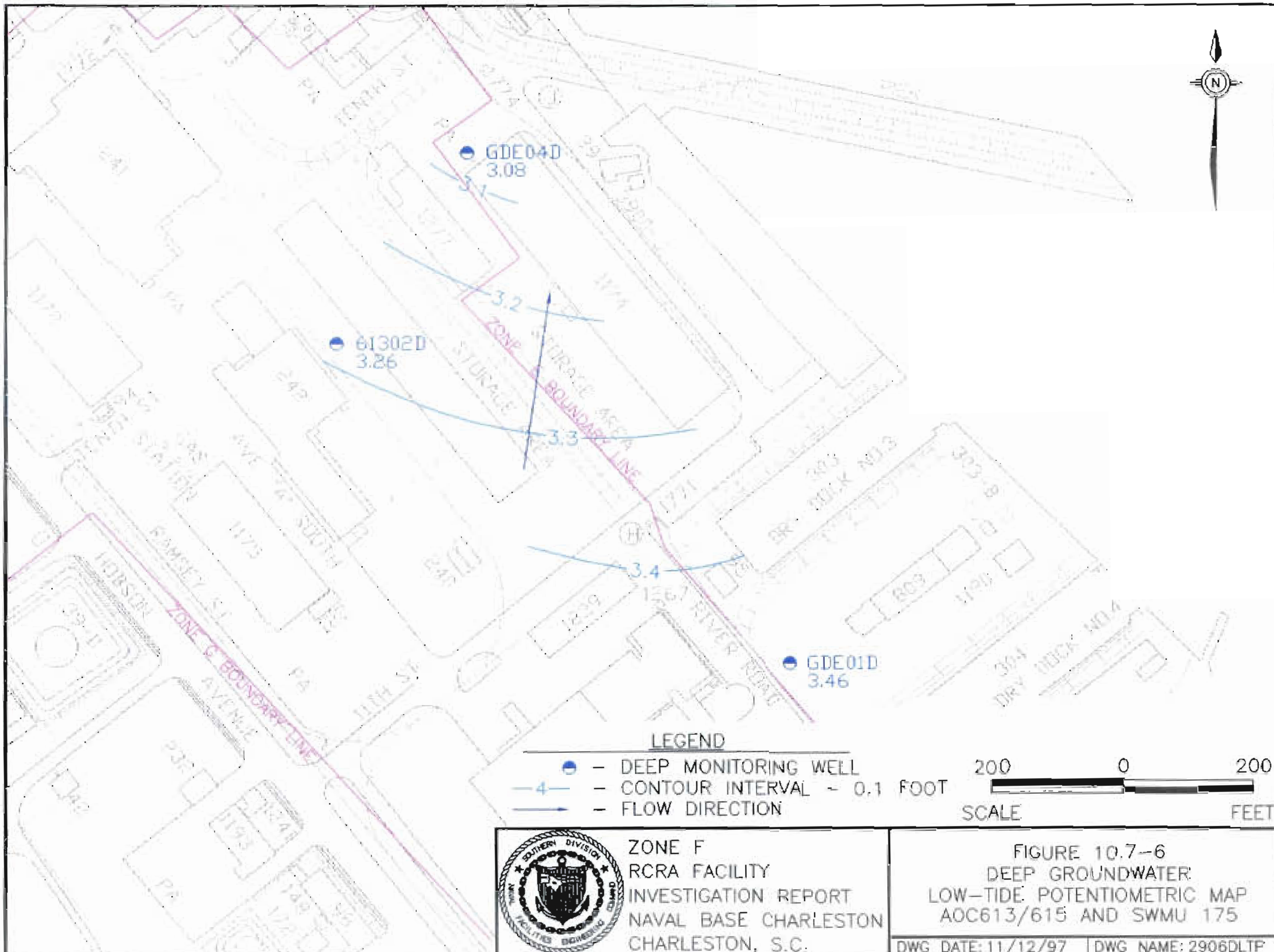


FIGURE 10.7-6
DEEP GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC613/615 AND SWMU 175

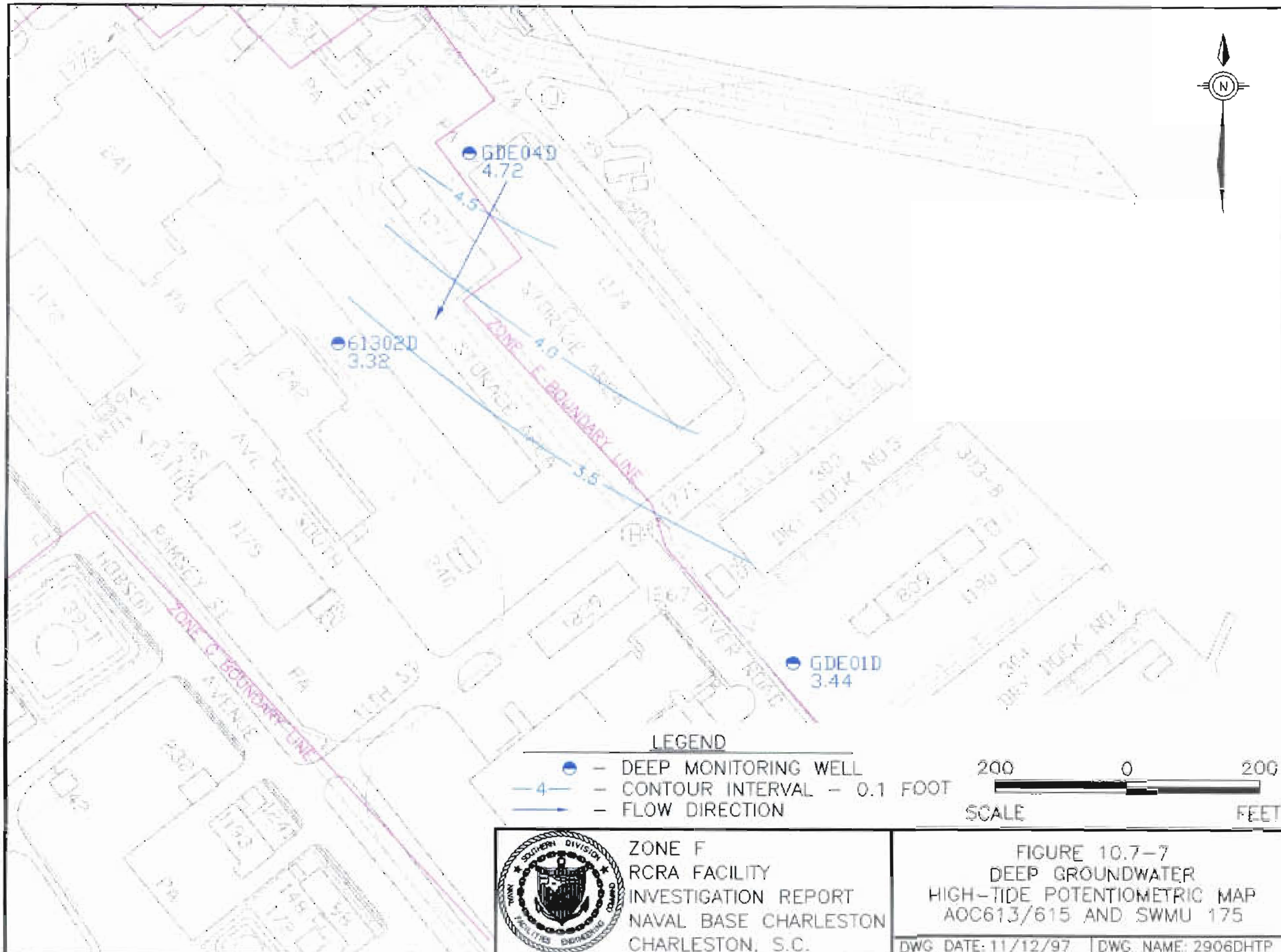


FIGURE 10.7-7
DEEP GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC613/615 AND SWMU 175

DWG DATE: 11/12/97 | DWG NAME: 2906DHTP

details the methods used during the field investigation. Included in this section are descriptions of the hollow stem auger procedures used for shallow well installation; the Rotasonic drilling procedures used for the onsite deep well; the DPT sampling procedures used for soil and groundwater screening sample collection; sediment and groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses.

Appendix D contains the data report for samples collected in Zone F.

10.7.3 DPT Screening Survey

A DPT survey was performed in the AOCs 613/615 and SWMU area to identify the extent that soil and shallow groundwater may have been impacted. Push sample points were spaced on 50- foot square grids, dependent on the layout of the site (buildings, obstructions, etc.). Composite samples of unsaturated soil were collected at each grid node. Interval soil sampling during the screening survey was considered unnecessary. This was because the site is mostly paved, thereby reducing the potential for direct exposure and the impact of precipitation leaching contaminants to groundwater from above the saturated zone. Screening soil samples were analyzed for metals, SVOAs, and VOAs at DQO III. Though the work plan called for soil analyses to include asbestos, this analysis was not performed. Groundwater samples were collected at nodes which yielded water. Groundwater screening samples were analyzed for similar parameters as the soil samples, if sufficient sample volume could be collected. If insufficient groundwater was available for full parameter analysis, priority for analysis was generally given to VOAs. The sampling grid over the site area was densified as necessary to determine the extent of contamination identified through the screening process. In all, 65 soil and 58 groundwater screening samples were collected, along with six duplicate soil and five duplicate groundwater samples, as depicted in Figure 10.7-3. Duplicates were analyzed for Appendix IX parameters at DQO Level IV.

The approved final RFI work plan proposed the screening survey results be used to optimize placement of the 10 discrete soil borings, and the three shallow and one deep monitoring wells proposed for this investigation. However, the soil screening data was of sufficient quality, and site coverage extensive enough, for this data to be used in lieu of the proposed discrete soil sampling. Therefore, no discrete soil samples were collected. Soil and groundwater screening data were used for monitoring well placement as planned. Table 10.7.1 summarizes the AOCs 613/615 and SWMU 175 screening samples and analyses.

Table 10.7.1
AOCs 613/615 and SWMU 175
Screening Samples and Analyses

Screening Location	Sample Identifier	Matrix	Date Collected	Analyses	Remarks
613SP001	613SP00101 613CP00101* 613GP00101	Soil Groundwater	9/12/96	Note 1 Note 2	 Duplicate Sample
613SP002	613SP00201 613GP00201	Soil Groundwater	9/13/96	Note 1 See remarks	GP002-SVOAs, VOAs only
613SP003	613SP00301 613GP00301	Soil Groundwater	8/29/96	Note 1	
613SP004	613SP00401 613GP00401	Soil Groundwater	10/02/96	Note 1	
613SP005	613SP00501 613GP00501	Soil Groundwater	10/03/96	Note 1 See remarks	GP005-VOAs only
613SP006	613SP00601 613GP00601	Soil Groundwater	10/04/96	Note 1 See remarks	GP006-metals, SVOAs only
613SP007	613SP00701 613GP00701	Soil Groundwater	9/12/96	Note 1	
613SP008	613SP00801 613GP00801	Soil Groundwater	9/13/96	Note 1 See remarks	GP008-VOAs only
613SP009	613SP00901 613GP00901	Soil Groundwater	8/29/96	Note 1 See remarks	GP009-VOAs only
613SP010	613SP01001 613GP01001	Soil Groundwater	10/02/96	Note 1	
613SP012	613SP01201 613CP01201* 613GP01201	Soil Groundwater	10/10/96	Note 1 Note 2 See remarks	 Duplicate Sample GP012-VOAs only

Table 10.7.1
AOCs 613/615 and SWMU 175
Screening Samples and Analyses

Screening Location	Sample Identifier	Matrix	Date Collected	Analyses	Remarks
613SP013	613SP01301	Soil	10/07/96	Note 1	
	613GP01301	Groundwater			
613SP014	613SP01401	Soil	9/12/96	Note 1	
613SP017	613SP01701	Soil	10/03/96	Note 1	GP017-VOAs only
	613GP01701	Groundwater		See remarks	
613SP018	613SP01801	Soil	10/04/96	Note 1	
613SP019	613SP01901	Soil	10/07/96	Note 1	
	613GP01901	Groundwater	10/08/96		
613SP020	613SP02001	Soil	9/11/96	Note 1	GP020-VOAs only
	613GP02001	Groundwater	9/12/96	See remarks	
613SP021	613SP02101	Soil	8/29/96	Note 1	
	613GP02101	Groundwater			
613SP022	613SP02201	Soil	9/15/96	Note 1	GP022-VOAs only
	613GP02201	Groundwater		See remarks	
613SP023	613SP02301	Soil	9/14/96	Note 1	
613SP024	613SP02401	Soil	9/11/96	Note 1	GP024-metals, VOAs only
	613GP02401	Groundwater		See remarks	
613SP025	613SP02501	Soil	8/28/96	Note 1	GP025-SVOAs, VOAs only
	613GP02501	Groundwater	8/29/96	See remarks	
613SP026	613SP02601	Soil	9/15/96	Note 1	GP026-VOAs only
	613GP02601	Groundwater		See remarks	
613SP027	613SP02701	Soil	9/14/96	Note 1	GP027-VOAs only
	613GP02701	Groundwater	9/15/96	See remarks	
613SP028	613SP02801	Soil	9/11/96	Note 1	
	613GP02081	Groundwater			
613SP029	613SP02901	Soil	8/28/96	Note 1	
	613GP02901	Groundwater			
613SP030	613SP03001	Soil	9/28/96	Note 1	
	613GP03001	Groundwater			
	613HP03001*			Note 2	Duplicate Sample
613SP031	613SP03101	Soil	9/14/96	Note 1	GP031-metals, VOAs only
	613GP03101	Groundwater		See remarks	
613SP032	613SP03201	Soil	9/10/96	Note 1	
	613GP03201	Groundwater			
613SP033	613SP03301	Soil	8/28/96	Note 1	
	613GP03301	Groundwater			

Table 10.7.1
AOCs 613/615 and SWMU 175
Screening Samples and Analyses

Screening Location	Sample Identifier	Matrix	Date Collected	Analyses	Remarks
613SP034	613SP03401	Soil	9/28/96	Note 1	
	613GP03401	Groundwater			
613SP035	613SP03501	Soil	9/16/96	Note 1	
	613GP03501	Groundwater			
613SP036	613SP03601	Soil	9/09/96	Note 1	
	613GP03601	Groundwater			
613SP037	613SP03701	Soil	8/30/96	Note 1	
	613GP03701	Groundwater			
613SP038	613SP03801	Soil	8/28/96	Note 1	
	613GP03801	Groundwater	9/16/96		
613SP039	613SP03901	Soil	9/29/96	Note 1	GP031-metals, VOAs only
	613GP03901	Groundwater		See remarks	
613SP040	613SP04001	Soil	9/13/96	Note 1	
	613GP04001	Groundwater			
613SP041	613SP04101	Soil	9/10/96	Note 1	
	613GP04101	Groundwater			
	613HP00101*			Note 2	Duplicate Sample
613SP042	613SP04201	Soil	9/03/96	Note 1	
	613GP04201	Groundwater			
613SP043	613SP04301	Soil	9/09/96	Note 1	
	613GP04301	Groundwater			
613SP044	613SP04401	Soil	8/27/96	Note 1	
	613GP04401	Groundwater			
613SP045	613SP04501	Soil	9/29/96	Note 1	
613SP046	613SP04601	Soil	10/09/96	Note 1	
	613GP04601	Groundwater			
613SP047	613SP04701	Soil	10/08/96	Note 1	
	613GP04701	Groundwater			
613SP048	613SP04801	Soil	9/10/96	Note 1	
	613GP04801	Groundwater			
613SP049	613SP04901	Soil	9/09/96	Note 1	
	613GP04901	Groundwater			
613SP050	613SP05001	Soil	9/04/96	Note 1	
	613GP05001	Groundwater			
	613HP05001*			Note 2	Duplicate Sample
613SP051	613SP05101	Soil	8/27/96	Note 1	
	613GP05101	Groundwater			

Table 10.7.1
AOCs 613/615 and SWMU 175
Screening Samples and Analyses

Screening Location	Sample Identifier	Matrix	Date Collected	Analyses	Remarks
613SP052	613SP05201	Soil	10/09/96	Note 1	
	613GP05201	Groundwater			
613SP053	613SP05301	Soil	9/17/96	Note 1	GP053-VOAs only
	613GP05301	Groundwater		See remarks	
613SP054	613SP05401	Soil	9/17/96	Note 1	GP054-VOAs only
	613GP05401	Groundwater		See remarks	
613SP055	613SP05501	Soil	9/13/96	Note 1	
613SP056	613SP05601	Soil	9/03/96	Note 1	GP056-VOAs only
	613GP05601	Groundwater		See remarks	
613SP057	613SP05701	Soil	8/30/96	Note 1	
	613GP05701	Groundwater			
613SP058	613SP05801	Soil	8/30/96	Note 1	
	613GP05801	Groundwater			
613SP059	613SP05901	Soil	9/03/96	Note 1	
	613GP05901	Groundwater			
613SP060	613SP06001	Soil	9/03/96	Note 1	
	613GP06001	Groundwater	9/04/96		
613SP061	613SP06101	Soil	9/16/96	Note 1	
613SP062	613SP06201	Soil	9/16/96	Note 1	
613SP063	613SP06301	Soil	10/16/96	Note 1	
	613GP06301	Groundwater			
613SP064	613SP06401	Soil	10/15/96	Note 1	
	613GP06401	Groundwater			
613SP065	613SP06501	Soil	10/14/96	Note 1	
	613CP06501*			Note 2	Duplicate Sample
	613GP06501	Groundwater		Note 1	
	613HP06501*			Note 2	Duplicate Sample
613SP066	613SP06601	Soil	10/13/96	Note 1	
	613CP06601*			Note 2	Duplicate Sample
	613GP06601	Groundwater			
613SP067	613SP06701	Soil	10/11/96	Note 1	
	613CP06701*			Note 2	Duplicate Sample
	613GP06701	Groundwater	10/12/96		

Table 10.7.1
AOCs 613/615 and SWMU 175
Screening Samples and Analyses

Screening Location	Sample Identifier	Matrix	Date Collected	Analyses	Remarks
613SP068	613SP06801	Soil	10/10/96	Note 1	HP068-Appendix IX
	613CP06801*			Note 2	Duplicate Sample
	613GP06801	Groundwater	10/11/96	See remarks	VOAs only.
	613HP06801*			Note 2	Duplicate Sample

Notes:
1 = SW-846 (metals, SVOAs, VOAs) at DQO Level III.
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanides; hex-chrome at DQO Level IV.
* = Duplicate sample.

10.7.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.7.2. Inorganic analytical results for soil are summarized in Table 10.7.3. Table 10.7.4 presents a summary of all analytes detected in soil at AOC 613/615 and SWMU 175. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organics in Soil

Fifteen VOCs were detected in surface soil samples. None of the detections exceeded its respective RBC. Three VOCs were detected in the subsurface soil sample below the respective SSL. No VOCs exceeded the RBC or SSL at the combined site.

Semivolatile Organic Compounds in Soil

Twenty-three SVOCs were detected surface soil. Concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were detected in surface soils above their respective RBCs. Figure 10.7-8 illustrates the distribution of these compounds as total BEQs concentrations in surface soil. Benzo(a)anthracene was detected in the subsurface soil sample exceeding its SSL. Figure 10.7-9 illustrates the distribution in subsurface soil.

Table 10.7.2
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (μg/kg)						
2-Butanone (MEK)	Upper	22/65	3.0 - 55.0	15.0	4700000	0
	Lower	0/1	ND	ND	790	0
2-Hexanone	Upper	1/65	18.0 - 18.0	18.0	NL	NA
	Lower	0/1	ND	ND	NL	NA
1,1-Dichloroethane	Upper	2/65	1.0 - 2.0	1.5	780000	0
	Lower	0/1	ND	ND	23000	0
1,1-Dichloroethene	Upper	1/65	3.0 - 3.0	3.0	1100	0
	Lower	0/1	ND	ND	60	0
1,2-Dichloroethene (total)	Upper	1/65	13. - 14.0	13.5	70000	0
	Lower	0/1	ND	ND	400	0
1,1,2,2-Tetrachloroethane	Upper	1/65	32.0 - 32.0	32.0	NL	NA
	Lower	0/1	ND	ND	NL	NA
Acetone	Upper	1/65	170.0 - 170.0	170.0	780000	0
	Lower	0/1	ND	ND	16000	0
Benzene	Upper	5/65	3.0 - 55.0	15.0	22000	0
	Lower	0/1	ND	ND	30	0
Carbon disulfide	Upper	12/65	2.0 - 110.0	12.83	780000	0
	Lower	1/1	14.0	14.0	32000[a]	0
Ethylbenzene	Upper	2/65	1.0 - 30.0	15.50	780000	0
	Lower	1/1	32.0	32.0	13000	0

Table 10.7.2
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Methylene chloride	Upper	7/65	1.0 - 50.0	16.0	85000	0
	Lower	0/1	ND	ND	20	0
Toluene	Upper	5/65	3.0 - 26.0	12.60	1600000	0
	Lower	0/1	ND	ND	12000	0
Trichloroethene	Upper	9/65	1.0 - 23.0	5.44	58000	0
	Lower	0/1	ND	ND	60	0
Vinyl chloride	Upper	1/65	2.0 - 2.0	2.0	340	0
	Lower	0/1	ND	ND	10	0
Xylene (total)	Upper	4/65	4.0 - 120.0	35.50	16000000	0
	Lower	1/1	46.0	46.0	190000	0
Semivolatile Organic Compounds (μg/kg)						
BEQ[1]	Upper	25/65	5.980 - 1775.300	230.04	88	15
	Lower	NA	NA	NA	NA	0
2-Methylnaphthalene	Upper	10/65	66.0 -6800.0	1213.8	310000	0
	Lower	1/1	43000.0	43000.0	12600	0
4-Methylphenol (p-Cresol)	Upper	1/65	81.0 - 81.0	81.0	39000	0
	Lower	0/1	ND	ND	1380	0
Acenaphthene	Upper	9/65	58.0 - 590.0	228.89	470000	0
	Lower	1/1			570000	0
Acenaphthylene	Upper	1/65	120.0 - 120.0	120.0	470000	0
	Lower	0/1	ND	ND	11000	0

Table 10.7.2
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Anthracene	Upper	9/65	89.0 - 3800.0	740.00	2300000	0
	Lower	1/1	26000.00	26000.0	12000000	0
Benzo(a)anthracene	Upper	17/65	43.0 - 2400.0	313.91	880	1
	Lower	1/1	5300.0	5300.0	2000	1
Benzo(a)pyrene	Upper	22/65	47.0 - 1200.0	191.27	88	11
	Lower	1/1	1200.0	1200.0	8000	0
Benzo(b)fluoranthene	Upper	16/65	46.0 - 1800.0	300.84	880	2
	Lower	1/1	2700.0	2700.0	5000	0
Benzo(g,h,i)perylene	Upper	13/65	51.0 - 250.0	115.0	230000	0
	Lower	1/1	360.0	360.0	4.66e+08	0
Benzo(k)fluoranthene	Upper	16/65	45.0 - 1500.0	236.06	8800	0
	Lower	0/1	ND	ND	49000	0
Benzoic acid	Upper	10/65	51.0 - 100.0	69.30	31000000	0
	Lower	0/1	ND	ND	400000	0
bis(2-Ethylhexyl)phthalate	Upper	19/65	41.0 - 380.0	120.74	46000	0
	Lower	0/1	ND	ND	3600000	0
Butylbenzlphthalate	Upper	1/65	170.0 - 170.0	170.0	1600000	0
	Lower	0/1	ND	ND	930000[d]	0
Chrysene	Upper	19/65	45.0 - 3000.0	436.42	88000	0
	Lower	1/1	3300.0	3300.0	160000	0

Table 10.7.2
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Dibenz(a,h)anthracene	Upper	4/65	46.0 - 130.0	87.50	88	2
	Lower	1/1	270.0	270.0	2000	0
Dibenzofuran	Upper	6/65	64.0 - 470.0	209.0	31000	0
	Lower	1/1	46000.0	46000.0	240000	0
Di-n-butylphthalate	Upper	1/65	74.0 - 74.0	74.0	780000	0
	Lower	0/1	ND	ND	2300000	0
Fluoranthene	Upper	23/65	62.0 - 4500.0	454.65	310000	0
	Lower	1/1	32000.0	32000.0	4300000	0
Fluorene	Upper	12/65	59.0 - 1100.0	321.67	310000	0
	Lower	1/1	60000.0	60000.0	560000	0
Indeno(1,2,3-cd)pyrene	Upper	9/65	55.00 - 280.00	146.56	880	0
	Lower	1/1	450.0	450.0	14000	0
Naphthalene	Upper	1/65	81.0 - 81.0	81.0	310000	0
	Lower	0/1	ND	ND	84000	0
Phenanthrene	Upper	20/65	44.0 - 3100.0	535.95	230000	0
	Lower	0/1	ND	ND	1380000	0
Pyrene	Upper	30/65	48.0 - 8500.0	540.60	230000	0
	Lower	0/1	ND	ND	4200000	0

Table 10.7.2
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Dioxin (ng/kg)						
Dioxin (2,3,7,8-TCDD TEQ[1])	Upper	1/1	0.0361-0.0361	0.0361	1000	0
	Lower	0/0	ND	ND	1900	0

Notes:

- [1] = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
- [a] = Calculated values correspond to a noncancer hazard quotient of 1.
- [b] = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
- [c] = SSL for pH of 6.8.
- [d] = Soil saturation concentration (C_{sat}).
- * = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
- ND = Not detected
- NL = Not listed
- NA = Not applicable
- ng/kg = Nanograms per kilogram
- μg/kg = Micrograms per kilgram

Table 10.7.3
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detection (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 6 Samples plus 3 Duplicate Samples/Lower Interval - 4 Samples) (mg/kg)						
Aluminum	Upper	65/65	2570.0 - 2670.0	12358.46	7800	53
	Lower	1/1	10000.0	10000.0	1000000	0
Antimony	Upper	3/65	0.5300 - 1.10	0.72	3.1	0
	Lower	0/1	ND	ND	5	0
Arsenic	Upper	65/65	0.7100 - 44.800	10.00	0.43	65
	Lower	1/1	13.0	13.0	29[b]	0
Barium	Upper	65/65	7.30 - 48.0	22.37	550	0
	Lower	1/1	18.6	18.60	1600[b]	0
Beryllium	Upper	60/65	0.1100 - 1.700	0.67	0.15	52
	Lower	1/1	0.78	0.78	63[b]	0
Cadmium	Upper	39/65	0.0400 - 1.500	0.28	3.9	0
	Lower	1/1	0.21	0.21	8[b]	0
Calcium	Upper	65/65	441.00 - 346000.00	18192.59	NL	NA
	Lower	1/1	23100.0	23100.0	NL	NA
Chromium	Upper	65/65	4.00 - 48.10	22.30	39	10
	Lower	1/1	29.5	29.5	38[b]	0
Cobalt	Upper	65/65	0.3500 - 8.300	3.14	470	0
	Lower	1/1	4.1	4.1	2000	0
Copper	Upper	49/65	0.9200 - 143.000	18.53	310	0
	Lower	1/1	15.6	15.6	920	0

Table 10.7.3
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detection (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Iron	Upper	65/65	1750.0 - 36200.0	16811.23	2300	64
	Lower	1/1	18200.0	18200.0	NL	NA
Lead	Upper	65/65	1.5 - 103.0	26.8946	400[c]	0
	Lower	1/1	31.9	31.9	400[c]	0
Magnesium	Upper	65/65	157.0 - 6545.0	2163.55	NL	NA
	Lower	1/1	2960.0	2960.0	NL	NA
Manganese	Upper	65/65	7.4 - 775.5	177.90	180	24
	Lower	1/1	309.0	309.0	1100	0
Mercury	Upper	52/65	0.0400 - 0.98	0.19	2.3	0
	Lower	1/1	0.23	0.23	2.0[b]	0
Nickel	Upper	63/65	1.10 - 15.90	6.79	160	0
	Lower	1/1	9.70	9.70	130[b]	0
Potassium	Upper	55/65	239.00 - 3005.00	1229.98	NL	NA
	Lower	1/1	1330.00	1330.0	NL	NA
Selenium	Upper	50/65	0.4100 - 2.60	1.07	39	0
	Lower	0/1	0.95	0.95	5	0
Silver	Upper	1/65	0.2700 - 0.27	0.27	39	0
	Lower	0/1	NA	NA	34	0
Sodium	Upper	51/65	166.00 - 6950.00	1218.99	NL	NA
	Lower	1/1	1810.00	1810.0	NL	NA

Table 10.7.3
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detection (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Thallium	Upper	24/65	0.47-1.50	0.83	0.63	16
	Lower	0/1	ND	ND	1.24	0
Vanadium	Upper	65/65	3.8 - 80.6	35.99	55	12
	Lower	1/1	36.00	36.00	6000[a]	0
Zinc	Upper	60/65	5.90 - 159.00	56.74	2300	0
	Lower	1/1	66.10	66.10	12000[a,b]	0

Notes:

a = Calculated values correspond to a noncancer hazard quotient of 1.
b = SSL for pH of 6.8.
c = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA 1994a).
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
ND = Not detected.
NL = Not listed.
NA = Not applicable.

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
1,1,2,2-Tetrachloroethane	613SP031	32.0	3200	NA	NT	3.0	NA
1,1-Dichloroethane	613SP057	2.0	780000	NA	NT	23000	NA
	613SP059	1.0		NA	NT		NA
1,1-Dichloroethene	613SP046	3.0	1100	NA	NT	60	NA
1,2-Dichloroethene (total)	613SP034	14.0		NA	NT		NA
	613SP039	13.0	70000	NA	NT	400	NA
2-Butanone (MEK)	613SP001	44.0	470000	NA	NT	790	NA
	613SP003	4.0		NA	NT		NA
	613SP009	17.0		NA	NT		NA
	613SP013	5.0		NA	NT		NA
	613SP018	3.0		NA	NT		NA
	613SP019	8.0		NA	NT		NA
	613SP021	6.0		NA	NT		NA
	613SP025	9.0		NA	NT		NA
	613SP027	22.0		NA	NT		NA
	613SP029	8.0		NA	NT		NA
	613SP031	24.0		NA	NT		NA
	613SP035	41.0		NA	NT		NA
	613SP040	5.0		NA	NT		NA
	613SP044	14.0		NA	NT		NA
	613SP046	18.0		NA	NT		NA
	613SP047	4.0		NA	NT		NA
	613SP050	8.0		NA	NT		NA
	613SP051	10.0		NA	NT		NA
	613SP055	10.0		NA	NT		NA
	613SP061	11.0		NA	NT		NA
	613SP062	55.0		NA	NT		NA
	613SP063	4.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
2-Hexanone	613SP046	18.0	630000	NA	NT	27600	NA
Acetone	613SP027	170.0	780000	NA	NT	16000	NA
Benzene	613SP042	11.0	22000	NA	NT	30	NA
	613SP046	3.0		NA	NT		NA
	613SP051	2.0		NA	NT		NA
	613SP059	4.0		NA	NT		NA
	613SP061	2.0		NA	NT		NA
Carbon disulfide	613SP010	2.0	780000	NA	NT	32000[a]	NA
	613SP012	8.5		NA	NT		NA
	613SP014	2.0		NA	NT		NA
	613SP022	5.0		NA	14.0		NA
	613SP026	4.0		NA	NT		NA
	613SP030	3.0		NA	NT		NA
	613SP045	9.0		NA	NT		NA
	613SP053	110.0		NA	NT		NA
	613SP056	2.0		NA	NT		NA
	613SP062	2.0		NA	NT		NA
	613SP067	2.0		NA	NT		NA
	613SP068	4.5		NA	NT		NA
Ethylbenzene	613SP022	ND	780000	NA	32.0	13000	NA
	613SP031	30.0		NA	NT		NA
	613SP039	1.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Methylene chloride	613SP002	1.0	85000	NA	NT	20	NA
	613SP014	2.0		NA	NT		NA
	613SP020	2.0		NA	NT		NA
	613SP023	50.0		NA	NT		NA
	613SP026	50.0		NA	NT		NA
	613SP027	3.0		NA	NT		NA
	613SP051	4.0		NA	NT		NA
Toluene	613SP030	9.0	1600000	NA	NT	12000	NA
	613SP034	9.0		NA	NT		NA
	613SP039	26.0		NA	NT		NA
	613SP045	16.0		NA	NT		NA
	613SP046	3.0		NA	NT		NA
Trichloroethene	613SP010	8.0	58000	NA	NT	60	NA
	613SP012	3.0		NA	NT		NA
	613SP019	23.0		NA	NT		NA
	613SP039	4.0		NA	NT		NA
	613SP042	2.0		NA	NT		NA
	613SP046	3.0		NA	NT		NA
	613SP051	2.0		NA	NT		NA
	613SP061	1.0		NA	NT		NA
	613SP067	3.0		NA	NT		NA
Vinyl chloride	613SP034	2.0	340	NA	NT	10	NA
Xylene (total)	613SP022	ND	16000000	NA	46.0	190000	NA
	613SP031	120.0		NA	NT		NA
	613SP039	5.0		NA	NT		NA
	613SP045	13.0		NA	NT		NA
	613SP051	4.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	613SP009	**226.23**	88	NA	NA	NA	NA
	613SP010	**105.86**		NA	NA	NA	NA
	613SP012	**95.57**		NA	NA	NA	NA
	613SP021	**1086.40**		NA	NA	NA	NA
	613SP022	**305.93**		NA	NA	NA	NA
	613SP024	**108.23**		NA	NA	NA	NA
	613SP029	**564.78**		NA	NA	NA	NA
	613SP031	5.98		NA	NA	NA	NA
	613SP032	82.03		NA	NA	NA	NA
	613SP034	86.57		NA	NA	NA	NA
	613SP035	82.16		NA	NA	NA	NA
	613SP044	59.00		NA	NA	NA	NA
	613SP047	50.00		NA	NA	NA	NA
	613SP050	**97.00**		NA	NA	NA	NA
	613SP051	**1775.30**		NA	NA	NA	NA
	613SP052	7.80		NA	NA	NA	NA
	613SP053	**243.82**		NA	NA	NA	NA
	613SP054	56.40		NA	NA	NA	NA
	613SP060	**98.00**		NA	NA	NA	NA
	613SP061	**239.47**		NA	NA	NA	NA
	613SP062	71.50		NA	NA	NA	NA
	613SP064	**100.00**		NA	NA	NA	NA
	613SP065	**94.32**		NA	NA	NA	NA
	613SP066	**98.54**		NA	NA	NA	NA
	613SP068	10.07		NA	NA	NA	NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds ($\mu g/kg$)							
2-Methylnaphthalene	613SP005	3000.0	310000	NA	NT	126000	NA
	613SP006	480.0		NA	NT		NA
	613SP022	ND		NA	43000.0		NA
	613SP031	6800.0		NA	NT		NA
	613SP035	740.0		NA	NT		NA
	613SP040	230.0		NA	NT		NA
	613SP043	90.0		NA	NT		NA
	613SP044	380.0		NA	NT		NA
	613SP045	72.0		NA	NT		NA
	613SP046	280.0		NA	NT		NA
	613SP051	66.0		NA	NT		NA
4-Methylphenol (p-Cresol)	613SP012	81.0	39000	NA	NT	1380	NA
Acenaphthene	613SP005	180.0	470000	NA	NT	570000	NA
	613SP006	160.0			NT		
	613SP022	ND			55000.0		
	613SP029	97.0			NT		
	613SP031	590.0			NT		
	613SP044	85.0			NT		
	613SP051	580.0			NT		
	613SP053	58.0			NT		
	613SP061	160.0			NT		
	613SP065	150.0			NT		
Acenaphthylene	613SP051	120.0	470000	NA	NT	11000	NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Anthracene	613SP009	98.0	2300000	NA	NT	12000000	NA
	613SP021	3800.0		NA	NT		NA
	613SP022	ND		NA	26000		NA
	613SP029	130.0		NA	NT		NA
	613SP031	550.0		NA	NT		NA
	613SP035	150.0		NA	NT		NA
	613SP051	1600.0		NA	NT		NA
	613SP053	93.0		NA	NT		NA
	613SP061	150.0		NA	NT		NA
	613SP065	89.0		NA	NT		NA
Benzo(a)anthracene	613SP009	160.0	880	NA	NT	2000	NA
	613SP010	100.0		NA	NT		NA
	613SP012	95.0		NA	NT		NA
	613SP021	860.0		NA	NT		NA
	613SP022	200.0		NA	**5300.0**		NA
	613SP024	70.0		NA	NT		NA
	613SP029	380.0		NA	NT		NA
	613SP032	70.0		NA	NT		NA
	613SP034	75.0		NA	NT		NA
	613SP035	110.0		NA	NT		NA
	613SP051	**2400.0**		NA	NT		NA
	613SP053	220.0		NA	NT		NA
	613SP054	43.0		NA	NT		NA
	613SP061	280.0		NA	NT		NA
	613SP062	55.0		NA	NT		NA
	613SP065	108.5		NA	NT		NA
	613SP066	110.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Benzo(a)pyrene	613SP009	**180.0**	88	NA	NT	8000	NA
	613SP010	87.0		NA	NT		NA
	613SP012	78.0		NA	NT		NA
	613SP021	**740.0**		NA	NT		NA
	613SP022	**190.0**		NA	1200.0		NA
	613SP024	**92.0**		NA	NT		NA
	613SP029	**440.0**		NA	NT		NA
	613SP032	69.0		NA	NT		NA
	613SP034	71.0		NA	NT		NA
	613SP035	71.0		NA	NT		NA
	613SP044	59.0		NA	NT		NA
	613SP047	50.0		NA	NT		NA
	613SP050	**97.0**		NA	NT		NA
	613SP051	**1200.0**		NA	NT		NA
	613SP053	**190.0**		NA	NT		NA
	613SP054	47.0		NA	NT		NA
	613SP060	**98.0**		NA	NT		NA
	613SP061	**130.0**		NA	NT		NA
	613SP062	65.0		NA	NT		NA
	613SP064	**100.0**		NA	NT		NA
	613SP065	75.0		NA	NT		NA
	613SP066	79.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Benzo(b)fluoranthene	613SP009	180.0	880	NA	NT	5000	NA
	613SP010	79.0		NA	ND		NA
	613SP021	**950.0**		NA	ND		NA
	613SP022	200.0		NA	2700.0		NA
	613SP024	83.0		NA	ND		NA
	613SP029	580.0		NA	ND		NA
	613SP032	53.0		NA	ND		NA
	613SP034	72.0		NA	ND		NA
	613SP051	**1800.0**		NA	ND		NA
	613SP052	78.0		NA	ND		NA
	613SP053	180.0		NA	ND		NA
	613SP054	46.0		NA	ND		NA
	613SP061	260.0		NA	ND		NA
	613SP065	75.5		NA	ND		NA
	613SP066	77.0		NA	ND		NA
	613SP068	100.0		NA	ND		NA
Benzo(g,h,i)perylene	613SP009	85.0	230000	NA	NT	4.66E+08	NA
	613SP012	73.0		NA	NT		NA
	613SP021	210.0		NA	NT		NA
	613SP022	100.0		NA	360.0		NA
	613SP029	210.0		NA	NT		NA
	613SP031	160.0		NA	NT		NA
	613SP035	54.0		NA	NT		NA
	613SP051	250.0		NA	NT		NA
	613SP053	110.0		NA	NT		NA
	613SP061	82.0		NA	NT		NA
	613SP062	55.0		NA	NT		NA
	613SP065	55.0		NA	NT		NA
	613SP066	51.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds ($\mu g/kg$)							
Benzo(k)fluoranthene	613SP009	200.0	8800	NA	NT	49000	NA
	613SP010	84.0		NA	NT		NA
	613SP012	88.0		NA	NT		NA
	613SP021	640.0		NA	NT		NA
	613SP022	76.0		NA	ND		NA
	613SP024	84.0		NA	NT		NA
	613SP029	420.0		NA	NT		NA
	613SP032	66.0		NA	NT		NA
	613SP034	78.0		NA	NT		NA
	613SP051	1500.0		NA	NT		NA
	613SP053	160.0		NA	NT		NA
	613SP054	45.0		NA	NT		NA
	613SP061	91.0		NA	NT		NA
	613SP062	94.0		NA	NT		NA
	613SP065	79.0		NA	NT		NA
	613SP066	72.0		NA	NT		NA
Benzoic acid	613SP002	53.0	31000000	NA	NT	400000	NA
	613SP008	86.0		NA	NT		NA
	613SP010	72.0		NA	NT		NA
	613SP047	51.0		NA	NT		NA
	613SP051	68.0		NA	NT		NA
	613SP053	60.0		NA	NT		NA
	613SP055	67.0		NA	NT		NA
	613SP059	58.0		NA	NT		NA
	613SP065	100.0		NA	NT		NA
	613SP066	78.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
bis(2-ethylhexyl)phthalate	613SP001	109.0	46000	NA	NT	3600000	NA
	613SP009	130.0		NA	NT		NA
	613SP021	47.0		NA	NT		NA
	613SP022	140.0		NA	ND		NA
	613SP023	68.0		NA	NT		NA
	613SP025	380.0		NA	NT		NA
	613SP026	79.0		NA	NT		NA
	613SP027	41.0		NA	NT		NA
	613SP033	380.0		NA	NT		NA
	613SP041	45.0		NA	NT		NA
	613SP042	67.0		NA	NT		NA
	613SP050	130.0		NA	NT		NA
	613SP056	73.0		NA	NT		NA
	613SP058	43.0		NA	NT		NA
	613SP061	190.0		NA	NT		NA
	613SP062	63.0		NA	NT		NA
	613SP063	110.0		NA	NT		NA
	613SP065	150.0		NA	NT		NA
	613SP066	49.0		NA	NT		NA
Butylbenzylphthalate	613SP012	170.0	1600000	NA	NT	930000[c]	NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Chrysene	613SP009	230.0	88000	NA	NT	160000	NA
	613SP010	120.0		NA	NT		NA
	633SP012	87.0		NA	NT		NA
	613SP021	3000.0		NA	NT		NA
	613SP022	170.0		NA	3300.0		NA
	613SP024	90.0		NA	NT		NA
	613SP029	580.0		NA	NT		NA
	613SP031	480.0		NA	NT		NA
	613SP032	73.0		NA	NT		NA
	613SP034	91.0		NA	NT		NA
	613SP035	160.0		NA	NT		NA
	613SP051	2300.0		NA	NT		NA
	613SP053	220.0		NA	NT		NA
	613SP054	45.0		NA	NT		NA
	613SP061	260.0		NA	NT		NA
	613SP062	64.0		NA	NT		NA
	613SP065	130.0		NA	NT		NA
	613SP066	120.0		NA	NT		NA
	613SP068	72.0		NA	NT		NA
Di-n-butylphthalate	613SP012	74.0	780000	NA	NT	2300000	NA
Dibenz(a,h)anthracene	613SP021	**130.0**	88	NA	NT	2000	NA
	613SP022	64.0		NA	270.0		NA
	613SP051	**110.0**		NA	NT		NA
	613SP061	46.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Dibenzofuran	613SP005	160.0	31000	NA	NT	240000	NA
	613SP006	110.0		NA	NT		NA
	613SP022	ND		NA	46000.0		NA
	613SP031	470.0		NA	NT		NA
	613SP051	330.0		NA	NT		NA
	613SP061	64.0		NA	NT		NA
	613SP065	120.0		NA	NT		NA
Fluoranthene	613SP008	72.0	31000	NA	NT	4300000	NA
	613SP009	450.0		NA	NT		NA
	613SP010	240.0		NA	NT		NA
	613SP012	92.0		NA	NT		NA
	613SP021	820.0		NA	NT		NA
	613SP022	350.0		NA	32000.0		NA
	613SP024	100.0		NA	NT		NA
	613SP026	62.0		NA	NT		NA
	613SP029	580.0		NA	NT		NA
	613SP031	350.0		NA	NT		NA
	613SP032	150.0		NA	NT		NA
	613SP034	150.0		NA	NT		NA
	613SP044	200.0		NA	NT		NA
	613SP045	99.0		NA	NT		NA
	613SP051	4500.0		NA	NT		NA
	613SP053	450.0		NA	NT		NA
	613SP054	63.0		NA	NT		NA
	613SP061	1000.0		NA	NT		NA
	613SP062	97.0		NA	NT		NA
	613SP065	290.0		NA	NT		NA
	613SP066	135.0		NA	NT		NA
	613SP067	77.0		NA	NT		NA
	613SP068	130.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds ($\mu g/kg$)							
Fluorene	613SP005	360.0	310000	NA	NT	560000	NA
	613SP006	380.0		NA	NT		NA
	613SP021	71.0		NA	NT		NA
	613SP022	ND		NA	60000.0		NA
	613SP029	59.0		NA	NT		NA
	613SP031	1000.0		NA	NT		NA
	613SP035	300.0		NA	NT		NA
	613SP040	69.0		NA	NT		NA
	613SP043	160.0		NA	NT		NA
	613SP044	84.0		NA	NT		NA
	613SP051	1100.0		NA	NT		NA
	613SP061	87.0		NA	NT		NA
	613SP065	190.0		NA	NT		NA
Indeno(1,2,3-cd)pyrene	613SP009	100.0	880	NA	NT	14000	NA
	613SP012	71.0		NA	NT		NA
	613SP021	260.0		NA	NT		NA
	613SP022	110.0		NA	450.0		NA
	613SP029	240.0		NA	NT		NA
	613SP031	55.0		NA	NT		NA
	613SP051	280.0		NA	NT		NA
	613SP053	120.0		NA	NT		NA
	613SP061	83.0		NA	NT		NA
Naphthalene	613SP022	ND	310000	NA	38000.0	84000	NA
	613SP051	81.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds ($\mu g/kg$)							
Phenanthrene	613SP005	850.0	230000	NA	NT	1380000	NA
	613SP006	880.0		NA	NT		NA
	613SP009	120.0		NA	NT		NA
	613SP010	100.0		NA	NT		NA
	613SP019	68.0		NA	NT		NA
	613SP021	160.0		NA	NT		NA
	613SP022	200.0		NA	110000.0		NA
	613SP029	490.0		NA	NT		NA
	613SP031	2600.0		NA	NT		NA
	613SP032	44.0		NA	NT		NA
	613SP035	500.0		NA	NT		NA
	613SP040	160.0		NA	NT		NA
	613SP043	300.0		NA	NT		NA
	613SP044	130.0		NA	NT		NA
	613SP051	3100.0		NA	NT		NA
	613SP053	390.0		NA	NT		NA
	613SP061	87.0		NA	NT		NA
	613SP062	58.0		NA	NT		NA
	613SP065	410.0		NA	NT		NA
	613SP068	72.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds ($\mu g/kg$)							
Pyrene	613SP005	170.0	230000	NA	NT	4200000	NA
	613SP009	330.0		NA	NT		NA
	613SP010	230.0		NA	NT		NA
	613SP012	86.0		NA	NT		NA
	613SP013	48.0		NA	NT		NA
	613SP020	77.0		NA	NT		NA
	613SP021	1100.0		NA	NT		NA
	613SP022	310.0		NA	18000.0		NA
	613SP024	95.0		NA	NT		NA
	613SP026	71.0		NA	NT		NA
	613SP029	550.0		NA	NT		NA
	613SP031	1200.0		NA	NT		NA
	613SP032	100.0		NA	NT		NA
	613SP034	160.0		NA	NT		NA
	613SP035	460.0		NA	NT		NA
	613SP040	63.0		NA	NT		NA
	613SP044	150.0		NA	NT		NA
	613SP045	150.0		NA	NT		NA
	613SP046	56.0		NA	NT		NA
	613SP047	87.0		NA	NT		NA
	613SP051	8500.0		NA	NT		NA
	613SP053	400.0		NA	NT		NA
	613SP054	77.0		NA	NT		NA
	613SP056	79.0		NA	NT		NA
	613SP061	860.0		NA	NT		NA
	613SP062	93.0		NA	NT		NA
	613SP065	325.0		NA	NT		NA
	613SP066	165.0		NA	NT		NA
	613SP067	91.0		NA	NT		NA
	613SP068	135.0		NA	NT		NA

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Dioxin (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQ')	613SP001	0.0361	1000	NA	ND	1900	NA
Inorganics (mg/kg)							
Aluminum (Al)	613SP001	14550.0	7800	18500	NT	1000000	17100
	613SP002	9460.0			NT		
	613SP003	8620.0			NT		
	613SP004	**23200.0**			NT		
	613SP005	**18600.0**			NT		
	613SP006	8650.0			NT		
	613SP007	**24800.0**			NT		
	613SP008	**25400.0**			NT		
	613SP009	8030.0			NT		
	613SP010	15100.0			NT		
	613SP012	**23500.0**			NT		
	613SP013	9350.0			NT		
	613SP014	**21300.0**			NT		
	613SP017	8180.0			NT		
	613SP018	2570.0			NT		
	613SP019	9200.0			NT		
	613SP020	17200.0			NT		
	613SP021	7210.0			NT		
	613SP022	10600.0			10000		
	613SP023	5380.0			NT		
	613SP024	17500.0			NT		
	613SP025	7640.0			NT		
	613SP026	9290.0			NT		
	613SP027	8020.0			NT		
	613SP028	11900.0			NT		
	613SP029	7830.0			NT		
	613SP030	**18800.0**			NT		
	613SP031	11100.0			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Aluminum (Al) (continued)	613SP032	11000.0	7800	18500	NT	1000000	17100
	613SP033	7890.0			NT		
	613SP034	11800.0			NT		
	613SP035	8070.0			NT		
	613SP036	12800.0			NT		
	613SP037	11300.0			NT		
	613SP038	7400.0			NT		
	613SP039	3400.0			NT		
	613SP040	14400.0			NT		
	613SP041	4670.0			NT		
	613SP042	8550.0			NT		
	613SP043	6300.0			NT		
	613SP044	11900.0			NT		
	613SP045	13800.0			NT		
	613SP046	9190.0			NT		
	613SP047	10600.0			NT		
	613SP048	5890.0			NT		
	613SP049	4940.0			NT		
	613SP050	14600.0			NT		
	613SP051	4340.0			NT		
	613SP052	**21000.0**			NT		
	613SP053	**19500.0**			NT		
	613SP054	7870.0			NT		
	613SP055	17100.0			NT		
	613SP056	**26700.0**			NT		
	613SP057	13100.0			NT		
	613SP058	9310.0			NT		
	613SP059	17000.0			NT		
	613SP060	9840.0			NT		
	613SP061	6060.0			NT		
	613SP062	16900.0			NT		
	613SP063	12200.0			NT		
	613SP064	10900.0			NT		
	613SP065	14550.0			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Aluminum (Al) (continued)	613SP066	16250.0	7800	18500	NT	1000000	17100
	613SP067	14850.0			NT		
	613SP068	**24350.0**			NT		
Antimony (Sb)	613SP044	0.54	3.1	0.79	NT	5	NL
	613SP051	1.10			NT		
	613SP053	0.53			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Arsenic (As)	613SP001	7.85	0.43	19.9	NT	29[c]	18.2
	613SP002	5.70			NT		
	613SP003	4.30			NT		
	613SP004	17.40			NT		
	613SP005	17.50			NT		
	613SP006	8.70			NT		
	613SP007	**21.50**			NT		
	613SP008	**20.20**			NT		
	613SP009	4.00			NT		
	613SP010	15.60			NT		
	613SP012	**26.95**			NT		
	613SP013	10.20			NT		
	613SP014	**21.30**			NT		
	613SP017	8.90			NT		
	613SP018	2.90			NT		
	613SP019	4.00			NT		
	613SP020	19.40			NT		
	613SP021	2.00			NT		
	613SP022	6.00			13.0		
	613SP023	2.80			NT		
	613SP024	**44.80**			NT		
	613SP025	2.30			NT		
	613SP026	8.50			NT		
	613SP027	4.50			NT		
	613SP028	11.60			NT		
	613SP029	2.20			NT		
	613SP030	10.20			NT		
	613SP031	8.50			NT		
	613SP032	4.20			NT		
	613SP033	1.80			NT		
	613SP034	7.60			NT		
	613SP035	6.30			NT		
	613SP036	6.80			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Arsenic (As) (continued)	613SP037	5.00	0.43	19.9	NT	29[c]	18.2
	613SP038	2.10			NT		
	613SP039	1.00			NT		
	613SP040	6.30			NT		
	613SP041	3.20			NT		
	613SP042	5.60			NT		
	613SP043	2.40			NT		
	613SP044	18.90			NT		
	613SP045	11.00			NT		
	613SP046	9.00			NT		
	613SP047	7.80			NT		
	613SP048	0.71			NT		
	613SP049	3.50			NT		
	613SP050	17.40			NT		
	613SP051	6.10			NT		
	613SP052	**21.90**			NT		
	613SP053	17.60			NT		
	613SP054	3.50			NT		
	613SP055	6.40			NT		
	613SP056	15.20			NT		
	613SP057	14.40			NT		
	613SP058	7.20			NT		
	613SP059	8.10			NT		
	613SP060	4.70			NT		
	613SP061	5.00			NT		
	613SP062	**20.90**			NT		
	613SP063	6.80			NT		
	613SP064	6.90			NT		
	613SP065	11.00			NT		
	613SP066	10.70			NT		
	613SP067	19.00			NT		
	613SP068	**24.50**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Barium (Ba)	613SP001	29.05	550.0	61.5	NT	1600[c]	51.8
	613SP002	29.80			NT		
	613SP003	20.40			NT		
	613SP004	37.50			NT		
	613SP005	30.60			NT		
	613SP006	18.60			NT		
	613SP007	37.30			NT		
	613SP008	38.50			NT		
	613SP009	14.10			NT		
	613SP010	28.70			NT		
	613SP012	36.45			NT		
	613SP013	32.20			NT		
	613SP014	36.70			NT		
	613SP017	12.90			NT		
	613SP018	9.00			NT		
	613SP019	11.60			NT		
	613SP020	32.90			NT		
	613SP021	10.80			NT		
	613SP022	22.30			18.60		
	613SP023	9.70			NT		
	613SP024	27.80			NT		
	613SP025	12.40			NT		
	613SP026	17.00			NT		
	613SP027	13.80			NT		
	613SP028	19.40			NT		
	613SP029	9.80			NT		
	613SP030	20.60			NT		
	613SP031	20.80			NT		
	613SP032	14.60			NT		
	613SP033	9.00			NT		
	613SP034	17.50			NT		
	613SP035	15.10			NT		
	613SP036	22.70			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Barium (Ba) (continued)	613SP037	23.60	550.0	61.5	NT	1600[c]	51.8
	613SP038	10.70			NT		
	613SP039	7.80			NT		
	613SP040	22.70			NT		
	613SP041	24.80			NT		
	613SP042	48.00			NT		
	613SP043	17.40			NT		
	613SP044	19.70			NT		
	613SP045	23.20			NT		
	613SP046	17.90			NT		
	613SP047	22.70			NT		
	613SP048	7.30			NT		
	613SP049	10.50			NT		
	613SP050	28.60			NT		
	613SP051	19.50			NT		
	613SP052	33.00			NT		
	613SP053	32.00			NT		
	613SP054	15.70			NT		
	613SP055	28.90			NT		
	613SP056	39.20			NT		
	613SP057	20.80			NT		
	613SP058	20.40			NT		
	613SP059	24.40			NT		
	613SP060	14.60			NT		
	613SP061	12.30			NT		
	613SP062	30.10			NT		
	613SP063	20.40			NT		
	613SP064	23.00			NT		
	613SP065	30.55			NT		
	613SP066	21.75			NT		
	613SP067	24.90			NT		
	613SP068	37.75			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Beryllium (Be)	613SP001	0.49	0.15	1.05	NT	63[c]	1.20
	613SP002	0.57			NT		
	613SP003	0.70			NT		
	613SP004	**1.50**			NT		
	613SP005	**1.30**			NT		
	613SP006	0.65			NT		
	613SP007	**1.70**			NT		
	613SP008	**1.50**			NT		
	613SP009	0.19			NT		
	613SP010	0.94			NT		
	613SP012	**1.45**			NT		
	613SP013	0.66			NT		
	613SP014	**1.40**			NT		
	613SP017	0.35			NT		
	613SP020	1.00			NT		
	613SP021	0.14			NT		
	613SP022	0.71			0.78		
	613SP024	**1.20**			NT		
	613SP025	0.14			NT		
	613SP026	0.60			NT		
	613SP028	0.73			NT		
	613SP029	0.13			NT		
	613SP030	0.70			NT		
	613SP031	0.51			NT		
	613SP032	0.27			NT		
	613SP033	0.11			NT		
	613SP034	0.30			NT		
	613SP036	0.33			NT		
	613SP037	0.26			NT		
	613SP038	0.13			NT		
	613SP039	0.12			NT		
	613SP040	0.68			NT		
	613SP041	0.23			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Beryllium (Be) (continued)	613SP042	0.25	0.15	1.05	NT	63[c]	1.20
	613SP043	0.18			NT		
	613SP044	0.87			NT		
	613SP045	0.96			NT		
	613SP046	0.55			NT		
	613SP047	0.45			NT		
	613SP048	0.14			NT		
	613SP049	0.23			NT		
	613SP050	1.00			NT		
	613SP051	0.18			NT		
	613SP052	**1.40**			NT		
	613SP053	**1.20**			NT		
	613SP054	0.44			NT		
	613SP055	0.71			NT		
	613SP056	**1.40**			NT		
	613SP057	0.85			NT		
	613SP058	0.34			NT		
	613SP059	0.35			NT		
	613SP060	0.37			NT		
	613SP061	0.35			NT		
	613SP062	**1.20**			NT		
	613SP063	0.52			NT		
	613SP064	0.69			NT		
	613SP065	0.75			NT		
	613SP066	0.55			NT		
	613SP067	**1.05**			NT		
	613SP068	**1.45**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cadmium (Cd)	613SP001	0.12	3.9	0.26	NT	8[c]	0.09
	613SP003	0.23			NT		
	613SP004	0.14			NT		
	613SP005	0.25			NT		
	613SP007	0.22			NT		
	613SP008	0.60			NT		
	613SP009	0.10			NT		
	613SP010	0.25			NT		
	613SP014	0.42			NT		
	613SP020	0.48			NT		
	613SP021	0.05			NT		
	613SP022	ND			0.21		
	613SP024	0.43			NT		
	613SP025	0.05			NT		
	613SP026	0.23			NT		
	613SP028	0.19			NT		
	613SP029	0.07			NT		
	613SP031	0.26			NT		
	613SP035	0.08			NT		
	613SP036	0.09			NT		
	613SP037	0.12			NT		
	613SP039	0.04			NT		
	613SP040	0.12			NT		
	613SP044	0.34			NT		
	613SP045	0.61			NT		
	613SP049	0.10			NT		
	613SP050	0.16			NT		
	613SP051	0.32			NT		
	613SP053	0.26			NT		
	613SP054	0.10			NT		
	613SP055	0.15			NT		
	613SP056	0.26			NT		
	613SP057	1.40			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cadmium (Cd) (continued)	613SP058	0.11	3.9	0.26	NT	8[c]	0.09
	613SP059	0.12			NT		
	613SP060	1.50			NT		
	613SP061	0.12			NT		
	613SP062	0.33			NT		
	613SP065	0.15			NT		
	613SP067	0.22			NT		
Calcium (Ca)	613SP001	875.50	NL	NL	NT	NL	NL
	613SP002	880.00			NT		
	613SP003	32600.00			NT		
	613SP004	12400.00			NT		
	613SP005	25600.00			NT		
	613SP006	6770.00			NT		
	613SP007	4870.00			NT		
	613SP008	5280.00			NT		
	613SP009	13300.00			NT		
	613SP010	54100.00			NT		
	613SP012	15450.00			NT		
	613SP013	6980.00			NT		
	613SP014	20100.00			NT		
	613SP017	7790.00			NT		
	613SP018	96000.00			NT		
	613SP019	1630.00			NT		
	613SP020	50200.00			NT		
	613SP021	1840.00			NT		
	613SP022	4740.00			23100.00		
	613SP023	485.00			NT		
	613SP024	21000.00			NT		
	613SP025	2550.00			NT		
	613SP026	26100.00			NT		
	613SP027	441.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Calcium (Ca) (continued)	613SP028	2970.00	NL	NL	NT	NL	NL
	613SP029	1080.00			NT		
	613SP030	1890.00			NT		
	613SP031	16800.00			NT		
	613SP032	913.00			NT		
	613SP033	704.00			NT		
	613SP034	1600.00			NT		
	613SP035	2840.00			NT		
	613SP036	1590.00			NT		
	613SP037	4150.00			NT		
	613SP038	730.00			NT		
	613SP039	3430.00			NT		
	613SP040	3160.00			NT		
	613SP041	575.00			NT		
	613SP042	2150.00			NT		
	613SP043	1570.00			NT		
	613SP044	7390.00			NT		
	613SP045	346000.00			NT		
	613SP046	59300.00			NT		
	613SP047	8090.00			NT		
	613SP048	1060.00			NT		
	613SP049	8280.00			NT		
	613SP050	3660.00			NT		
	613SP051	10800.00			NT		
	613SP052	12600.00			NT		
	613SP053	13000.00			NT		
	613SP054	3980.00			NT		
	613SP055	3650.00			NT		
	613SP056	19300.00			NT		
	613SP057	15100.00			NT		
	613SP058	690.00			NT		
	613SP059	755.00			NT		
	613SP060	1090.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Calcium (Ca) (continued)	613SP061	13500.00	NL	NL	NT	NL	NL
	613SP062	12800.00			NT		
	613SP063	5280.00			NT		
	613SP064	35500.00			NT		
	613SP065	56050.00			NT		
	613SP066	7560.00			NT		
	613SP067	52100.00			NT		
	613SP068	26850.00			NT		
Chromium (Cr)	613SP001	25.40	39 VI	34.8	NT	38[c] (total)	32.2
	613SP002	12.20	7800 III		NT		
	613SP003	27.20			NT		
	613SP004	**41.60**			NT		
	613SP005	**39.10**			NT		
	613SP006	19.30			NT		
	613SP007	**42.40**			NT		
	613SP008	38.40			NT		
	613SP009	9.20			NT		
	613SP010	29.20			NT		
	613SP012	**43.30**			NT		
	613SP013	18.70			NT		
	613SP014	**41.50**			NT		
	613SP017	15.80			NT		
	613SP018	6.30			NT		
	613SP019	9.90			NT		
	613SP020	33.70			NT		
	613SP021	8.00			NT		
	613SP022	16.20			29.50		
	613SP023	7.70			NT		
	613SP024	35.60			NT		
	613SP025	8.60			NT		
	613SP026	16.60			NT		
	613SP027	12.50			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr) (continued)	613SP028	22.00	39VI	34.8	NT	38[c] (total)	32.2
	613SP029	9.40	7800III		NT		
	613SP030	31.30			NT		
	613SP031	20.90			NT		
	613SP032	23.90			NT		
	613SP033	7.70			NT		
	613SP034	23.80			NT		
	613SP035	13.30			NT		
	613SP036	25.20			NT		
	613SP037	20.70			NT		
	613SP038	8.10			NT		
	613SP039	4.50			NT		
	613SP040	22.30			NT		
	613SP041	6.10			NT		
	613SP042	17.50			NT		
	613SP043	10.50			NT		
	613SP044	21.90			NT		
	613SP045	29.90			NT		
	613SP046	18.50			NT		
	613SP047	20.20			NT		
	613SP048	6.50			NT		
	613SP049	13.40			NT		
	613SP050	26.90			NT		
	613SP051	14.60			NT		
	613SP052	**39.60**			NT		
	613SP053	**40.00**			NT		
	613SP054	14.50			NT		
	613SP055	25.90			NT		
	613SP056	**48.10**			NT		
	613SP057	24.00			NT		
	613SP058	20.90			NT		
	613SP059	**39.40**			NT		
	613SP060	19.30			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr) (continued)	613SP061	12.00	39VI	34.8	NT	38[c] (total)	32.2
	613SP062	34.10	7800III		NT		
	613SP063	18.80			NT		
	613SP064	15.60			NT		
	613SP065	26.60			NT		
	613SP066	22.40			NT		
	613SP067	28.80			NT		
	613SP068	**42.50**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co)	613SP001	1.95	470.0	15.1	NT	2000	6.85
	613SP002	2.50			NT		
	613SP003	1.10			NT		
	613SP004	7.80			NT		
	613SP005	6.90			NT		
	613SP006	3.10			NT		
	613SP007	7.50			NT		
	613SP008	8.30			NT		
	613SP009	1.10			NT		
	613SP010	4.80			NT		
	613SP012	7.65			NT		
	613SP013	3.10			NT		
	613SP014	6.70			NT		
	613SP017	1.60			NT		
	613SP018	1.10			NT		
	613SP019	0.52			NT		
	613SP020	4.80			NT		
	613SP021	0.60			NT		
	613SP022	3.0			4.10		
	613SP023	0.70			NT		
	613SP024	7.40			NT		
	613SP025	0.60			NT		
	613SP026	3.70			NT		
	613SP027	0.67			NT		
	613SP028	3.90			NT		
	613SP029	0.50			NT		
	613SP030	3.30			NT		
	613SP031	2.60			NT		
	613SP032	1.20			NT		
	613SP033	0.35			NT		
	613SP034	1.10			NT		
	613SP035	1.90			NT		
	613SP036	1.40			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co) (continued)	613SP037	1.50	470.0	15.1	NT	2000	6.85
	613SP038	0.48			NT		
	613SP039	0.47			NT		
	613SP040	2.80			NT		
	613SP041	0.73			NT		
	613SP042	3.70			NT		
	613SP043	0.89			NT		
	613SP044	4.30			NT		
	613SP045	4.10			NT		
	613SP046	2.50			NT		
	613SP047	1.90			NT		
	613SP048	1.00			NT		
	613SP049	0.97			NT		
	613SP050	5.00			NT		
	613SP051	0.89			NT		
	613SP052	6.50			NT		
	613SP053	6.30			NT		
	613SP054	2.00			NT		
	613SP055	3.40			NT		
	613SP056	6.60			NT		
	613SP057	4.10			NT		
	613SP058	1.60			NT		
	613SP059	1.90			NT		
	613SP060	1.60			NT		
	613SP061	1.90			NT		
	613SP062	7.50			NT		
	613SP063	2.70			NT		
	613SP064	3.00			NT		
	613SP065	4.25			NT		
	613SP066	3.00			NT		
	613SP067	5.65			NT		
	613SP068	7.65			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Copper (Cu)	613SP002	4.70	310.0	48.2	NT	920	30.4
	613SP003	4.10			NT		
	613SP004	32.80			NT		
	613SP005	39.30			NT		
	613SP007	28.00			NT		
	613SP008	28.00			NT		
	613SP009	5.80			NT		
	613SP010	23.30			NT		
	613SP012	29.65			NT		
	613SP014	32.50			NT		
	613SP017	11.60			NT		
	613SP020	22.50			NT		
	613SP021	2.20			NT		
	613SP022	ND			15.60		
	613SP024	32.00			NT		
	613SP025	4.20			NT		
	613SP026	13.40			NT		
	613SP028	19.40			NT		
	613SP029	2.50			NT		
	613SP030	5.20			NT		
	613SP031	11.00			NT		
	613SP032	0.92			NT		
	613SP033	1.40			NT		
	613SP036	0.95			NT		
	613SP038	1.50			NT		
	613SP040	11.70			NT		
	613SP041	2.60			NT		
	613SP043	0.97			NT		
	613SP044	18.50			NT		
	613SP045	34.70			NT		
	613SP046	18.90			NT		
	613SP048	1.30			NT		
	613SP049	5.50			NT		
	613SP050	21.90			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Copper (Cu) (continued)	613SP051	43.90	310.0	48.2	NT	920	30.4
	613SP052	32.00			NT		
	613SP053	143.00			NT		
	613SP054	10.40			NT		
	613SP055	11.70			NT		
	613SP056	32.20			NT		
	613SP057	19.80			NT		
	613SP060	4.10			NT		
	613SP061	7.60			NT		
	613SP062	27.30			NT		
	613SP063	6.70			NT		
	613SP064	8.00			NT		
	613SP065	22.15			NT		
	613SP066	11.15			NT		
	613SP067	23.65			NT		
	613SP068	31.50			NT		
Iron (Fe)	613SP001	**21700.00**	2300.0	NL	NT	NL	NL
	613SP002	**8110.00**			NT		
	613SP003	**12200.00**			NT		
	613SP004	**36200.00**			NT		
	613SP005	**27700.00**			NT		
	613SP006	**13300.00**			NT		
	613SP007	**35400.00**			NT		
	613SP008	**26600.00**			NT		
	613SP009	**6630.00**			NT		
	613SP010	**20900.00**			NT		
	613SP012	**31150.00**			NT		
	613SP013	**13400.00**			NT		
	613SP014	**32500.00**			NT		
	613SP017	**14500.00**			NT		
	613SP018	**4990.00**			NT		
	613SP019	**7890.00**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Iron (Fe) (continued)	613SP020	**23800.00**	2300.0	NL	NT	NL	NL
	613SP021	**3300.00**			NT		
	613SP022	**22300.00**			18200.00		
	613SP023	**6450.00**			NT		
	613SP024	**33100.00**			NT		
	613SP025	**4830.00**			NT		
	613SP026	**11500.00**			NT		
	613SP027	**11500.00**			NT		
	613SP028	**18800.00**			NT		
	613SP029	**5770.00**			NT		
	613SP030	**24000.00**			NT		
	613SP031	**15300.00**			NT		
	613SP032	**14700.00**			NT		
	613SP033	**4340.00**			NT		
	613SP034	**21900.00**			NT		
	613SP035	**9250.00**			NT		
	613SP036	**20200.00**			NT		
	613SP037	**19800.00**			NT		
	613SP038	**5700.00**			NT		
	613SP039	**3120.00**			NT		
	613SP040	**15500.00**			NT		
	613SP041	**3860.00**			NT		
	613SP042	**16800.00**			NT		
	613SP043	**7070.00**			NT		
	613SP044	**21500.00**			NT		
	613SP045	**14800.00**			NT		
	613SP046	**11400.00**			NT		
	613SP047	**14200.00**			NT		
	613SP048	**1750.00**			NT		
	613SP049	**6890.00**			NT		
	613SP050	**21000.00**			NT		
	613SP051	**7740.00**			NT		
	613SP052	**31900.00**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Iron (Fe) (continued)	613SP053	**27800.00**	2300	NL	NT	NL	NL
	613SP054	**12000.00**			NT		
	613SP055	**18300.00**			NT		
	613SP056	**26900.00**			NT		
	613SP057	**20100.00**			NT		
	613SP058	**25000.00**			NT		
	613SP059	**25400.00**			NT		
	613SP060	**17000.00**			NT		
	613SP061	**7890.00**			NT		
	613SP062	**28300.00**			NT		
	613SP063	**14400.00**			NT		
	613SP064	**10400.00**			NT		
	613SP065	**6050.00**			NT		
	613SP066	**18400.00**			NT		
	613SP067	**22050.00**			NT		
	613SP068	**35500.00**			NT		
Lead(Pb)	613SP001	8.65	400.0^d	180	NT	400.0^d	51.7
	613SP002	14.40			NT		
	613SP003	5.10			NT		
	613SP004	60.50			NT		
	613SP005	60.90			NT		
	613SP006	12.20			NT		
	613SP007	52.80			NT		
	613SP008	54.60			NT		
	613SP009	11.20			NT		
	613SP010	38.30			NT		
	613SP012	42.10			NT		
	613SP013	27.20			NT		
	613SP014	45.80			NT		
	613SP017	37.90			NT		
	613SP018	6.60			NT		
	613SP019	4.30			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Lead (Pb) (continued)	613SP020	86.80	400.0[d]	180	NT	400.0[d]	51.7
	613SP021	5.50			NT		
	613SP022	9.10			31.90		
	613SP023	4.50			NT		
	613SP024	52.50			NT		
	613SP025	6.80			NT		
	613SP026	23.20			NT		
	613SP027	5.50			NT		
	613SP028	34.40			NT		
	613SP029	6.20			NT		
	613SP030	16.40			NT		
	613SP031	19.20			NT		
	613SP032	8.00			NT		
	613SP033	4.30			NT		
	613SP034	8.60			NT		
	613SP035	9.40			NT		
	613SP036	8.60			NT		
	613SP037	7.10			NT		
	613SP038	3.50			NT		
	613SP039	1.50			NT		
	613SP040	20.50			NT		
	613SP041	10.20			NT		
	613SP042	6.60			NT		
	613SP043	6.40			NT		
	613SP044	29.50			NT		
	613SP045	66.70			NT		
	613SP046	17.70			NT		
	613SP047	26.80			NT		
	613SP048	3.00			NT		
	613SP049	11.60			NT		
	613SP050	37.10			NT		
	613SP051	103.00			NT		
	613SP052	65.10			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Lead (Pb) (continued)	613SP053	78.60	400.0[d]	180	NT	400.0[d]	51.7
	613SP054	17.00			NT		
	613SP055	25.30			NT		
	613SP056	32.00			NT		
	613SP057	45.50			NT		
	613SP058	7.50			NT		
	613SP059	9.40			NT		
	613SP060	21.20			NT		
	613SP061	28.50			NT		
	613SP062	60.90			NT		
	613SP063	20.20			NT		
	613SP064	16.60			NT		
	613SP065	44.95			NT		
	613SP066	25.60			NT		
	613SP067	46.40			NT		
	613SP068	60.65			NT		
Magnesium (Mg)	613SP001	1144.50	NL	NL	NT	NL	NL
	613SP002	597.00			NT		
	613SP003	2110.00			NT		
	613SP004	4280.00			NT		
	613SP005	4450.00			NT		
	613SP006	1900.00			NT		
	613SP007	3630.00			NT		
	613SP008	3110.00			NT		
	613SP009	581.00			NT		
	613SP010	3670.00			NT		
	613SP012	5285.00			NT		
	613SP013	1990.00			NT		
	613SP014	5030.00			NT		
	613SP017	1040.00			NT		
	613SP018	1230.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Magnesium (Mg) (continued)	613SP019	306.00	NL	NL	NT	NL	NL
	613SP020	6060.00			NT		
	613SP021	262.00			NT		
	613SP022	1000.00			2960.00		
	613SP023	223.00			NT		
	613SP024	4570.00			NT		
	613SP025	291.00			NT		
	613SP026	1820.00			NT		
	613SP027	347.00			NT		
	613SP028	2340.00			NT		
	613SP029	227.00			NT		
	613SP030	1930.00			NT		
	613SP031	2010.00			NT		
	613SP032	1290.00			NT		
	613SP033	164.00			NT		
	613SP034	1170.00			NT		
	613SP035	869.00			NT		
	613SP036	1370.00			NT		
	613SP037	1680.00			NT		
	613SP038	157.00			NT		
	613SP039	206.00			NT		
	613SP040	1980.00			NT		
	613SP041	259.00			NT		
	613SP042	1230.00			NT		
	613SP043	710.00			NT		
	613SP044	2910.00			NT		
	613SP045	5500.00			NT		
	613SP046	2020.00			NT		
	613SP047	1340.00			NT		
	613SP048	329.00			NT		
	613SP049	667.00			NT		
	613SP050	3040.00			NT		
	613SP051	311.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Magnesium (Mg) (continued)	613SP052	5600.00	NL	NL	NT	NL	NL
	613SP053	4520.00			NT		
	613SP054	1290.00			NT		
	613SP055	2370.00			NT		
	613SP056	5290.00			NT		
	613SP057	2470.00			NT		
	613SP058	1320.00			NT		
	613SP059	1630.00			NT		
	613SP060	1440.00			NT		
	613SP061	1140.00			NT		
	613SP062	4580.00			NT		
	613SP063	1550.00			NT		
	613SP064	1930.00			NT		
	613SP065	3210.00			NT		
	613SP066	2385.00			NT		
	613SP067	4725.00			NT		
	613SP068	6545.00			NT		
Manganese (Mn)	613SP001	42.05	180.0	307	NT	1100	469
	613SP002	43.30			NT		
	613SP003	55.30			NT		
	613SP004	**414.00**			NT		
	613SP005	**650.00**			NT		
	613SP006	95.60			NT		
	613SP007	**344.00**			NT		
	613SP008	234.00			NT		
	613SP009	87.80			NT		
	613SP010	**370.00**			NT		
	613SP012	**461.00**			NT		
	613SP013	114.00			NT		
	613SP014	**433.00**			NT		
	613SP017	90.70			NT		
	613SP018	109.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn) (continued)	613SP019	11.60	180.0	307	NT	1100	469
	613SP020	**556.00**			NT		
	613SP021	12.40			NT		
	613SP022	77.90			309.00		
	613SP023	12.80			NT		
	613SP024	**755.00**			NT		
	613SP025	15.20			NT		
	613SP026	137.00			NT		
	613SP027	12.100			NT		
	613SP028	149.00			NT		
	613SP029	16.80			NT		
	613SP030	73.90			NT		
	613SP031	142.00			NT		
	613SP032	19.70			NT		
	613SP033	8.40			NT		
	613SP034	26.50			NT		
	613SP035	45.40			NT		
	613SP036	21.70			NT		
	613SP037	24.90			NT		
	613SP038	8.50			NT		
	613SP039	13.00			NT		
	613SP040	131.00			NT		
	613SP041	17.70			NT		
	613SP042	194.00			NT		
	613SP043	22.00			NT		
	613SP044	221.00			NT		
	613SP045	291.00			NT		
	613SP046	165.00			NT		
	613SP047	124.00			NT		
	613SP048	7.40			NT		
	613SP049	38.20			NT		
	613SP050	215.00			NT		
	613SP051	40.30			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn) (continued)	613SP052	**530.00**	180.0	307	NT	1100	469
	613SP053	**380.00**			NT		
	613SP054	118.00			NT		
	613SP055	233.00			NT		
	613SP056	301.00			NT		
	613SP057	189.00			NT		
	613SP058	45.80			NT		
	613SP059	33.40			NT		
	613SP060	37.20			NT		
	613SP061	65.50			NT		
	613SP062	**479.00**			NT		
	613SP063	274.00			NT		
	613SP064	157.00			NT		
	613SP065	260.00			NT		
	613SP066	219.50			NT		
	613SP067	**315.50**			NT		
	613SP068	**775.50**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg)	613SP001	0.11	2.3	0.62	NT	2[c]	0.23
	613SP002	0.07			NT		
	613SP004	0.37			NT		
	613SP005	0.48			NT		
	613SP006	0.07			NT		
	613SP007	0.28			NT		
	613SP008	0.34			NT		
	613SP009	0.06			NT		
	613SP010	0.30			NT		
	613SP012	0.15			NT		
	613SP014	0.12			NT		
	613SP017	0.26			NT		
	613SP018	0.13			NT		
	613SP020	0.05			NT		
	613SP021	0.98			NT		
	613SP022	0.20			0.23		
	613SP023	0.05			NT		
	613SP024	0.19			NT		
	613SP025	0.16			NT		
	613SP026	0.19			NT		
	613SP027	0.05			NT		
	613SP028	0.57			NT		
	613SP029	0.17			NT		
	613SP030	0.08			NT		
	613SP031	0.09			NT		
	613SP033	0.04			NT		
	613SP035	0.10			NT		
	613SP036	0.08			NT		
	613SP037	0.09			NT		
	613SP038	0.04			NT		
	613SP040	0.14			NT		
	613SP043	0.06			NT		
	613SP045	0.63			NT		
	613SP046	0.23			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg) (continued)	613SP047	0.06	2.3	0.62	NT	2^c	0.23
	613SP049	0.06			NT		
	613SP050	0.20			NT		
	613SP051	0.10			NT		
	613SP052	0.54			NT		
	613SP053	0.22			NT		
	613SP055	0.12			NT		
	613SP056	0.12			NT		
	613SP057	0.30			NT		
	613SP060	0.04			NT		
	613SP061	0.12			NT		
	613SP062	0.45			NT		
	613SP063	0.10			NT		
	613SP064	0.60			NT		
	613SP065	0.17			NT		
	613SP066	0.14			NT		
	613SP067	0.25			NT		
	613SP068	0.38			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Nickel (Ni)	613SP001	4.85	160.0	12.6	NT	130^c	8.85
	613SP002	5.20			NT		
	613SP003	9.50			NT		
	613SP004	13.80			NT		
	613SP005	14.30			NT		
	613SP006	4.40			NT		
	613SP007	10.30			NT		
	613SP008	13.90			NT		
	613SP009	3.60			NT		
	613SP010	10.40			NT		
	613SP012	14.15			NT		
	613SP013	5.00			NT		
	613SP014	14.30			NT		
	613SP017	2.90			NT		
	613SP018	3.90			NT		
	613SP020	15.00			NT		
	613SP021	2.20			NT		
	613SP022	2.20			9.70		
	613SP023	1.10			NT		
	613SP024	12.90			NT		
	613SP025	2.50			NT		
	613SP026	6.80			NT		
	613SP027	1.60			NT		
	613SP028	6.80			NT		
	613SP029	2.10			NT		
	613SP030	8.00			NT		
	613SP031	6.00			NT		
	613SP032	2.60			NT		
	613SP033	1.80			NT		
	613SP034	2.60			NT		
	613SP035	3.30			NT		
	613SP036	3.10			NT		
	613SP037	3.40			NT		
	613SP038	1.90			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Nickel (Ni) (continued)	613SP040	6.30	160.0	12.6	NT	130[c]	8.85
	613SP041	2.10			NT		
	613SP042	3.20			NT		
	613SP043	1.80			NT		
	613SP044	7.40			NT		
	613SP045	13.90			NT		
	613SP046	7.30			NT		
	613SP047	4.90			NT		
	613SP048	1.90			NT		
	613SP049	2.90			NT		
	613SP050	8.40			NT		
	613SP051	5.20			NT		
	613SP052	13.70			NT		
	613SP053	15.50			NT		
	613SP054	4.10			NT		
	613SP055	7.20			NT		
	613SP056	15.90			NT		
	613SP057	8.30			NT		
	613SP058	3.00			NT		
	613SP059	4.90			NT		
	613SP060	3.50			NT		
	613SP061	4.10			NT		
	613SP062	12.40			NT		
	613SP063	5.50			NT		
	613SP064	7.10			NT		
	613SP065	10.50			NT		
	613SP066	6.35			NT		
	613SP067	10.55			NT		
	613SP068	13.95			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Potassium (K)	613SP001	497.00	NL	NL	NT	NL	NL
	613SP002	318.00			NT		
	613SP003	589.00			NT		
	613SP004	2100.00			NT		
	613SP005	2190.00			NT		
	613SP006	1210.00			NT		
	613SP007	2000.00			NT		
	613SP008	1720.00			NT		
	613SP009	248.00			NT		
	613SP010	1640.00			NT		
	613SP012	2950.00			NT		
	613SP013	918.00			NT		
	613SP014	2520.00			NT		
	613SP015	653.00			NT		
	613SP018	239.00			NT		
	613SP019	400.00			NT		
	613SP020	1540.00			NT		
	613SP022	639.00			1330.00		
	613SP024	2040.00			NT		
	613SP026	827.00			NT		
	613SP027	337.00			NT		
	613SP028	1200.00			NT		
	613SP030	1070.00			NT		
	613SP031	1040.00			NT		
	613SP032	752.00			NT		
	613SP034	794.00			NT		
	613SP035	641.00			NT		
	613SP036	840.00			NT		
	613SP037	943.00			NT		
	613SP040	1180.00			NT		
	613SP042	296.00			NT		
	613SP043	252.00			NT		
	613SP044	1390.00			NT		
	613SP045	1680.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Potassium (K) (continued)	613SP046	881.00	NL	NL	NT	NL	NL
	613SP047	710.00			NT		
	613SP049	326.00			NT		
	613SP050	1530.00			NT		
	613SP052	2890.00			NT		
	613SP053	2410.00			NT		
	613SP054	717.00			NT		
	613SP055	1510.00			NT		
	613SP056	2970.00			NT		
	613SP057	1390.00			NT		
	613SP058	537.00			NT		
	613SP059	991.00			NT		
	613SP060	812.00			NT		
	613SP061	559.00			NT		
	613SP062	2100.00			NT		
	613SP063	941.00			NT		
	613SP064	869.00			NT		
	613SP065	1410.00			NT		
	613SP066	1228.00			NT		
	613SP067	2210.00			NT		
	613SP068	3005.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Selenium (Se)	613SP001	0.86	39	1.15	NT	5	1.24
	613SP003	1.00			NT		
	613SP004	2.60			NT		
	613SP005	1.80			NT		
	613SP006	0.77			NT		
	613SP007	1.80			NT		
	613SP008	1.50			NT		
	613SP010	1.40			NT		
	613SP012	1.24			NT		
	613SP013	0.84			NT		
	613SP014	1.10			NT		
	613SP017	0.61			NT		
	613SP020	1.10			NT		
	613SP022	0.76			0.95		
	613SP023	0.56			NT		
	613SP024	1.30			NT		
	613SP025	0.42			NT		
	613SP027	0.69			NT		
	613SP030	1.60			NT		
	613SP031	1.10			NT		
	613SP032	0.80			NT		
	613SP034	1.40			NT		
	613SP035	0.67			NT		
	613SP036	1.10			NT		
	613SP037	0.48			NT		
	613SP040	0.79			NT		
	613SP041	0.41			NT		
	613SP042	0.56			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Selenium (Se) (continued)	613SP043	0.48	39	1.15	NT	5	1.24
	613SP044	1.40			NT		
	613SP045	2.10			NT		
	613SP047	0.62			NT		
	613SP050	1.20			NT		
	613SP051	0.51			NT		
	613SP052	2.30			NT		
	613SP053	2.30			NT		
	613SP054	0.84			NT		
	613SP055	0.90			NT		
	613SP056	1.50			NT		
	613SP057	0.92			NT		
	613SP058	0.79			NT		
	613SP059	1.30			NT		
	613SP060	1.00			NT		
	613SP062	1.10			NT		
	613SP063	0.73			NT		
	613SP064	0.48			NT		
	613SP065	1.00			NT		
	613SP066	0.90			NT		
	613SP067	0.75			NT		
	613SP068	1.29			NT		
Silver (Ag)	613SP038	0.27	39	1.85	NT	34	NL

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Sodium (Na)	613SP001	504.50	NL	NL	NT	NL	NL
	613SP002	245.00			NT		
	613SP003	492.00			NT		
	613SP007	789.00			NT		
	613SP008	449.00			NT		
	613SP009	192.00			NT		
	613SP012	3125.00			NT		
	613SP014	2420.00			NT		
	613SP020	2380.00			NT		
	613SP021	178.00			NT		
	613SP022	456.00			1810.00		
	613SP023	179.00			NT		
	613SP024	1970.00			NT		
	613SP025	212.00			NT		
	613SP026	398.00			NT		
	613SP027	356.00			NT		
	613SP028	763.00			NT		
	613SP029	187.00			NT		
	613SP031	1120.00			NT		
	613SP032	628.00			NT		
	613SP033	166.00			NT		
	613SP035	395.00			NT		
	613SP036	774.00			NT		
	613SP037	998.00			NT		
	613SP038	172.00			NT		
	613SP040	896.00			NT		
	613SP041	220.00			NT		
	613SP042	972.00			NT		
	613SP043	955.00			NT		
	613SP044	966.00			NT		
	613SP048	221.00			NT		
	613SP049	516.00			NT		
	613SP050	683.00			NT		
	613SP051	227.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Sodium (Na) (continued)	613SP052	6950.00	NL	NL	NT	NL	NL
	613SP053	2520.00			NT		
	613SP054	297.00			NT		
	613SP055	805.00			NT		
	613SP056	2630.00			NT		
	613SP057	520.00			NT		
	613SP058	393.00			NT		
	613SP059	600.00			NT		
	613SP060	933.00			NT		
	613SP061	459.00			NT		
	613SP062	2390.00			NT		
	613SP063	667.00			NT		
	613SP064	1500.00			NT		
	613SP065	1975.00			NT		
	613SP066	1845.00			NT		
	613SP067	5560.00			NT		
	613SP068	6920.00			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Thallium (Tl)	613SP001	**0.88**	0.63	NL	NT	1.24	1.24
	613SP003	0.53			NT		
	613SP007	**0.73**			NT		
	613SP020	**0.85**			NT		
	613SP022	**0.93**			ND		
	613SP024	**0.70**			NT		
	613SP025	0.52			NT		
	613SP029	0.47			NT		
	613SP036	**1.20**			NT		
	613SP037	**0.76**			NT		
	613SP042	0.62			NT		
	613SP043	0.48			NT		
	613SP044	**1.50**			NT		
	613SP049	**0.87**			NT		
	613SP050	**1.40**			NT		
	613SP051	0.55			NT		
	613SP056	**0.95**			NT		
	613SP057	**0.90**			NT		
	613SP058	**0.90**			NT		
	613SP059	**1.30**			NT		
	613SP062	**1.10**			NT		
	613SP063	0.52			NT		
	613SP065	0.50			NT		
	613SP066	**0.75**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V)	613SP001	43.00	55.0	48.9	NT	6000*	49.4
	613SP002	19.70			NT		
	613SP003	20.80			NT		
	613SP004	**80.60**			NT		
	613SP005	**60.50**			NT		
	613SP006	38.40			NT		
	613SP007	**72.40**			NT		
	613SP008	**63.90**			NT		
	613SP009	13.30			NT		
	613SP010	44.80			NT		
	613SP012	**68.40**			NT		
	613SP013	31.30			NT		
	613SP014	**68.40**			NT		
	613SP017	30.60			NT		
	613SP018	6.00			NT		
	613SP019	33.40			NT		
	613SP020	48.00			NT		
	613SP021	12.10			NT		
	613SP022	26.90			36.0		
	613SP023	17.00			NT		
	613SP024	**71.30**			NT		
	613SP025	12.60			NT		
	613SP026	29.50			NT		
	613SP027	27.60			NT		
	613SP028	42.00			NT		
	613SP029	14.50			NT		
	613SP030	50.70			NT		
	613SP031	36.70			NT		
	613SP032	33.60			NT		
	613SP033	13.40			NT		
	613SP034	42.90			NT		
	613SP035	25.30			NT		
	613SP036	42.10			NT		
	613SP037	26.40			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V) (continued)	613SP038	14.50	55.0	48.9	NT	6000[a]	49.4
	613SP039	5.30			NT		
	613SP040	36.60			NT		
	613SP041	8.50			NT		
	613SP042	25.00			NT		
	613SP043	13.00			NT		
	613SP044	43.50			NT		
	613SP045	34.20			NT		
	613SP046	26.20			NT		
	613SP047	29.90			NT		
	613SP048	3.80			NT		
	613SP049	12.20			NT		
	613SP050	51.10			NT		
	613SP051	13.10			NT		
	613SP052	**80.40**			NT		
	613SP053	**64.20**			NT		
	613SP054	21.40			NT		
	613SP055	39.90			NT		
	613SP056	**59.40**			NT		
	613SP057	39.20			NT		
	613SP058	30.50			NT		
	613SP059	51.30			NT		
	613SP060	29.10			NT		
	613SP061	17.40			NT		
	613SP062	**64.90**			NT		
	613SP063	29.30			NT		
	613SP064	24.10			NT		
	613SP065	36.25			NT		
	613SP066	37.00			NT		
	613SP067	54.50			NT		
	613SP068	**75.75**			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Zinc (Zn)	613SP001	19.10	2300	198	NT	12000	84.2
	613SP002	15.70			NT		
	613SP003	22.40			NT		
	613SP004	115.00			NT		
	613SP005	159.00			NT		
	613SP006	31.00			NT		
	613SP007	117.00			NT		
	613SP008	113.00			NT		
	613SP009	27.20			NT		
	613SP010	94.70			NT		
	613SP012	127.00			NT		
	613SP013	54.60			NT		
	613SP014	146.00			NT		
	613SP017	42.80			NT		
	613SP018	28.70			NT		
	613SP020	109.00			NT		
	613SP021	7.50			NT		
	613SP022	16.30			66.10		
	613SP024	123.00			NT		
	613SP025	18.70			NT		
	613SP026	61.30			NT		
	613SP028	78.90			NT		
	613SP029	8.60			NT		
	613SP030	46.80			NT		
	613SP031	43.00			NT		
	613SP032	13.20			NT		
	613SP034	13.60			NT		
	613SP035	21.00			NT		
	613SP036	13.80			NT		
	613SP037	14.80			NT		
	613SP038	5.90			NT		
	613SP040	45.90			NT		
	613SP041	14.50			NT		
	613SP042	19.70			NT		

Table 10.7.4
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Zinc (Zn) (continued)	613SP043	10.20	2300	198	NT	12000	84.2
	613SP044	67.50			NT		
	613SP045	137.00			NT		
	613SP046	48.00			NT		
	613SP047	34.50			NT		
	613SP048	7.50			NT		
	613SP049	15.90			NT		
	613SP050	74.60			NT		
	613SP051	67.10			NT		
	613SP052	121.00			NT		
	613SP053	125.00			NT		
	613SP054	34.50			NT		
	613SP055	50.90			NT		
	613SP056	95.80			NT		
	613SP057	79.90			NT		
	613SP058	16.40			NT		
	613SP059	20.60			NT		
	613SP060	24.70			NT		
	613SP061	52.40			NT		
	613SP062	116.00			NT		
	613SP063	33.90			NT		
	613SP064	33.70			NT		
	613SP065	78.60			NT		
	613SP066	50.10			NT		
	613SP067	90.10			NT		
	613SP068	129.50			NT		

Notes:

a	=	Calculated values correspond to a noncancer hazard quotient of 1.
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c	=	SSL for pH of 6.8.
d	=	A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
e	=	Soil saturation concentration (C_{sat}).
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
!	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
ND	=	Not detected
NT	=	Not taken
NL	=	Not listed
NA	=	Not applicable
μg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram
ng/kg	=	Nanograms per kilogram

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.
All background reference values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

LEGEND:

● – DPT LOCATION

(blank box) <88 μg/kg

(hatched box) >88 μg/kg

(dashed outline) APPROXIMATE EXTENT

NOTES:

88 μg/kg = RBC FOR BEQs IN SURFACE SOIL (USEPA 1996b).

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ND = NOT DETECTED

NT = SAMPLE NOT TAKEN

ZONE F
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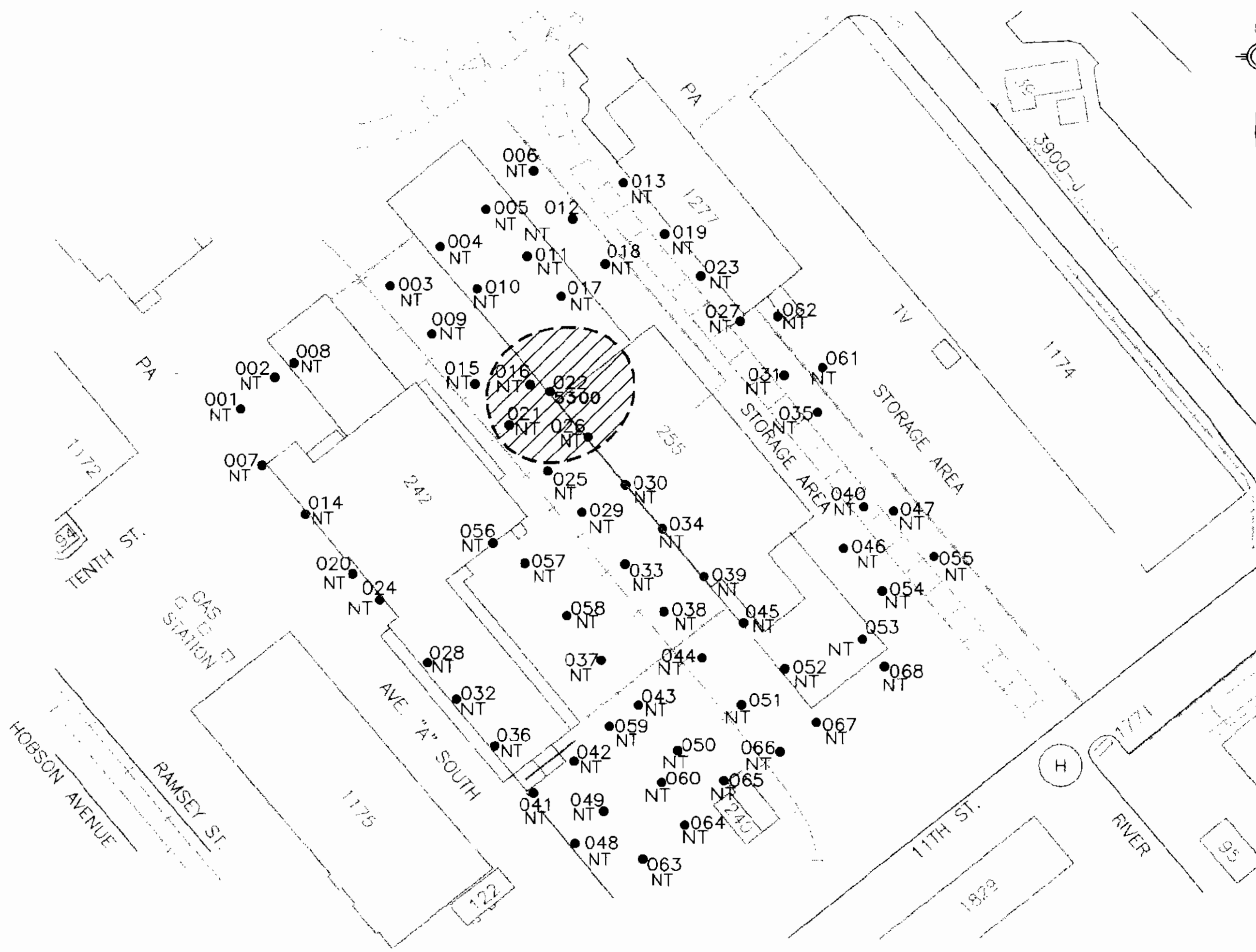
FIGURE 10.7-8
BEQs IN SURFACE SOILS
AOC 613 & 615
AND SWMU 175

Date: 16 DEC 97 | DWG Name: 29FNEW01



LEGEND:

- • – DPT LOCATION
- <2000 $\mu g/kg$
- >2000 $\mu g/kg$
- APPROXIMATE EXTENT

NOTES:

2000 $\mu g/kg$ = SSL FOR BENZO(a)ANTHRACENE IN SUBSURFACE SOIL (USEPA 1996b).

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

NT = LOWER NTERVAL NOT TAKEN

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FIGURE 10.7-9
BENZO(a)ANTHRACENE IN
SUBSURFACE SOIL-AOC 613 & 6
AND SWMU 175

Date: 17 DEC 97
DWG Name: 29FNEWC

Pesticides and PCBs in Soil

No pesticides or PCBs were detected in soil samples collected at the combined sites.

Other Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in one surface soil duplicate sample below its RBC.

Inorganic Elements in Soil

Twenty-three metals were detected in surface soil samples. Concentrations of aluminum, arsenic, beryllium, chromium, iron, manganese, thallium, and vanadium exceeded their respective RBCs. Figures 10.7-10 through 10.7-16 illustrates the distribution of these metals in surface soil at the combined site. No metals were detected in the subsurface soil sample exceeding SSLs.

10.7.4 Sediment Sampling and Analysis

The approved final RFI work plan proposed three sediment samples to assess the impact of contaminants reportedly introduced via disposal through drains to the sanitary sewer system traversing the area. Two sediment samples (613M0001 and 613M0002) were collected during the investigation, as depicted in Figure 10.7-2. Sediment samples were analyzed for metals, cyanide, SVOAs, and VOAs at DQO Level III, as specified for in the approved final RFI work plan. Asbestos analyses were not performed. One duplicate sample was analyzed for Appendix IX parameters at DQO Level IV. Table 10.7.4 summarizes the AOCs 613/615 and SWMU 175 sediment samples and analyses.

10.7.4.1 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.7.5. Inorganic analytical results for soil are summarized in Table 10.7.6. Table 10.7.7 summarizes analytes detected in sediment at the combined site.

LEGEND:

• – DPT LOCATION

<19.9 mg/kg

>19.9 mg/kg

APPROXIMATE EXTENT

100 0 100

SCALE IN FEET

NOTES:

19.9 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN SURFACE SOIL.

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

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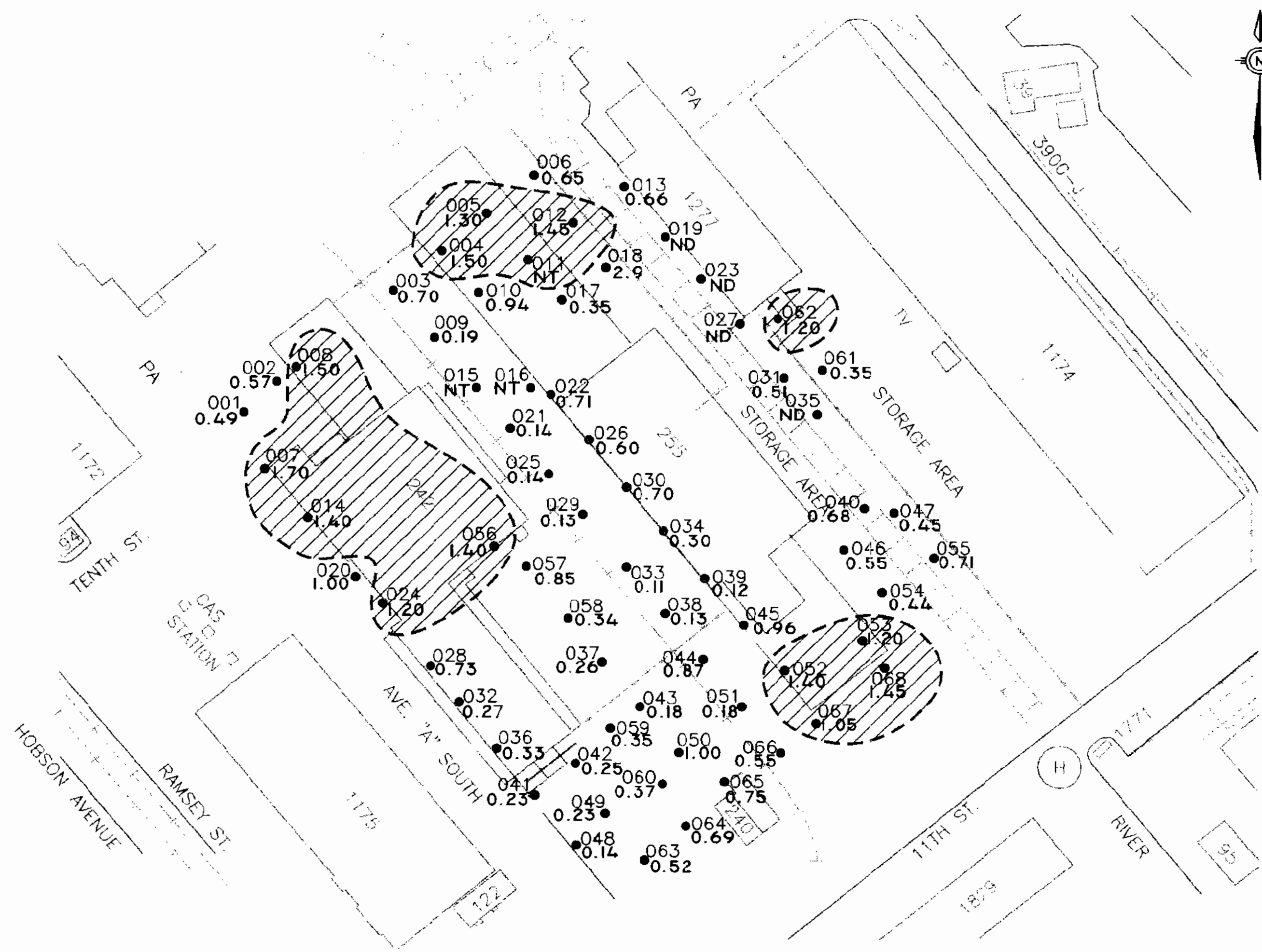
FIGURE 10.7-11
ARSENIC IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 18 DEC 97 | DWG Name: 29FNEW0



LEGEND:

- ● – DPT LOCATION
- ☐ <1.05 mg/kg
- ▨ >1.05 mg/kg
- APPROXIMATE EXTENT

NOTES:

1.05 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR BERYLLIUM IN SURFACE SOIL

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

ND = NOT DETECTED

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FIGURE 10.7-12
BERYLLIUM IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 18 DEC 97 | DWG Name: 29FNEW05

LEGEND:

• – DPT LOCATION

<39 mg/kg

>39 mg/kg

APPROXIMATE EXTENT

NOTES:

39 mg/kg = RBC FOR HEXAVALENT CHROMIU IN SURFACE SOIL(USEPA 1996b).

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

ND = NOT DETECTED

100 0 100

SCALE IN FEET

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FIGURE 10.7-13
CHROMIUM IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 18 DEC 97 | DWG Name: 29FNEWO

LEGEND:

● – DPT LOCATION

<307 mg/kg

>307 mg/kg

APPROXIMATE EXTENT

NOTES:

307 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR MANGANESE IN SURFACE SOI

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

ND = NOT DETECTED

100 0 100

SCALE IN FEET

ZONE F
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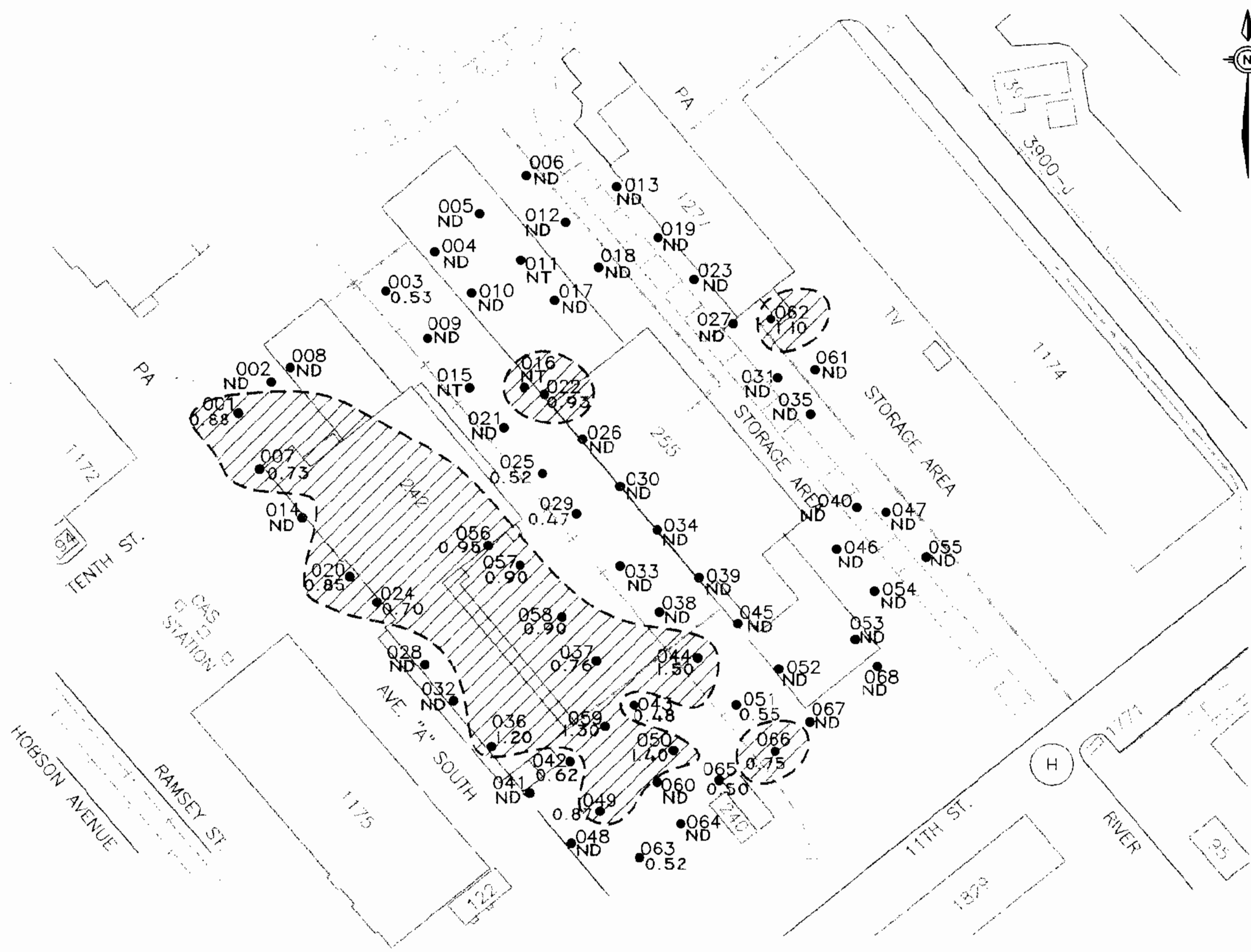
FIGURE 10.7-14
MANGANESE IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 18 DEC 97 | DWG Name: 29FNEW07



NOTES:

0.63 mg/kg = RBC FOR THALLIUM IN SURFACE SOIL (USEPA 1996b).

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

ND = NOT DETECTED

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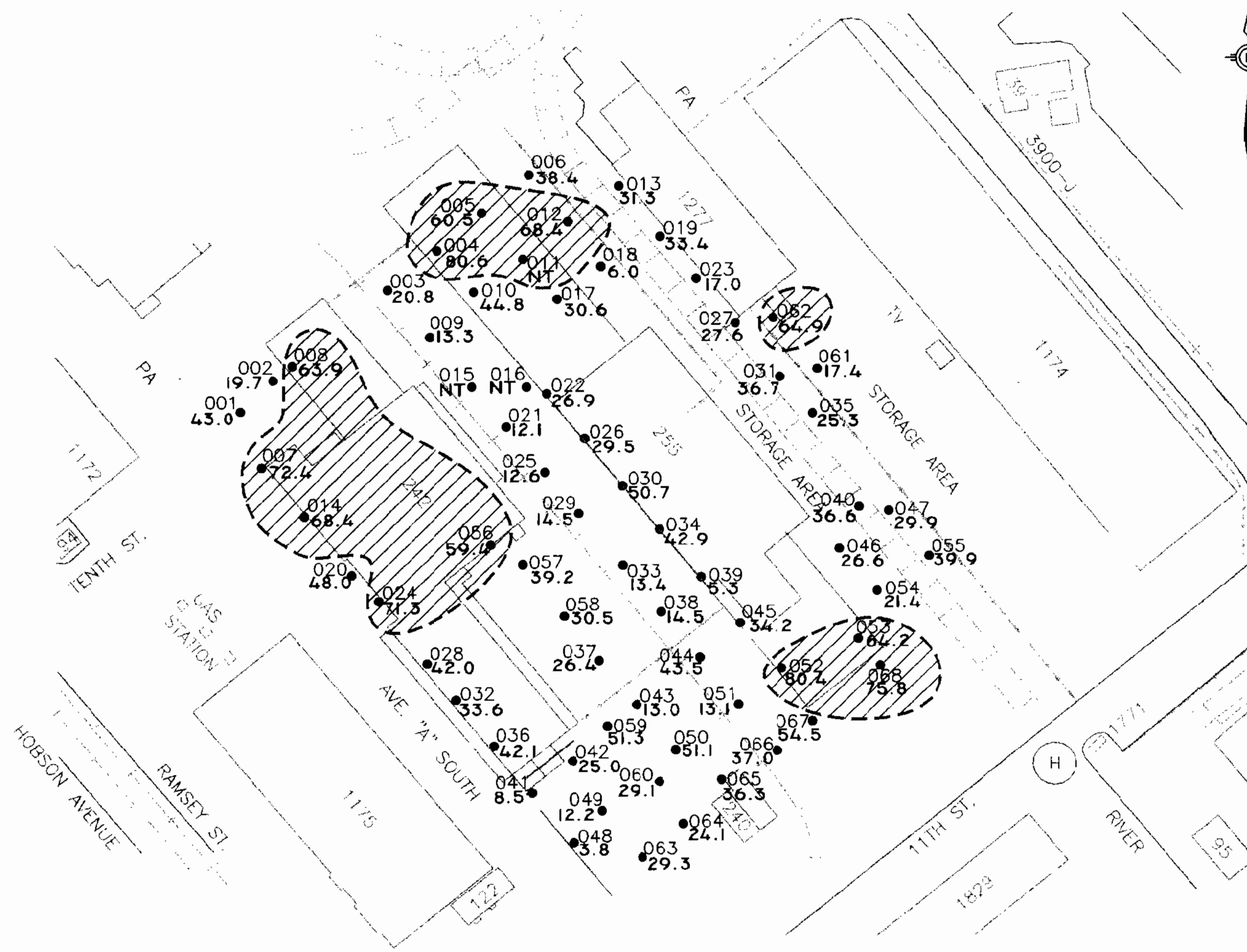
FIGURE 10.7-15
THALLIUM IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 18 DEC 97 | DWG Name: 29FNEW08



LEGEND:

- • – DPT LOCATION
- <55 mg/kg
- >55 mg/kg
- APPROXIMATE EXTENT

NOTES:

55 mg/kg = RBC FOR VANADIUM IN SURFACE SOIL (USEPA 1996b).

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

ND = NOT DETECTED

100 0 100

SCALE IN FEET

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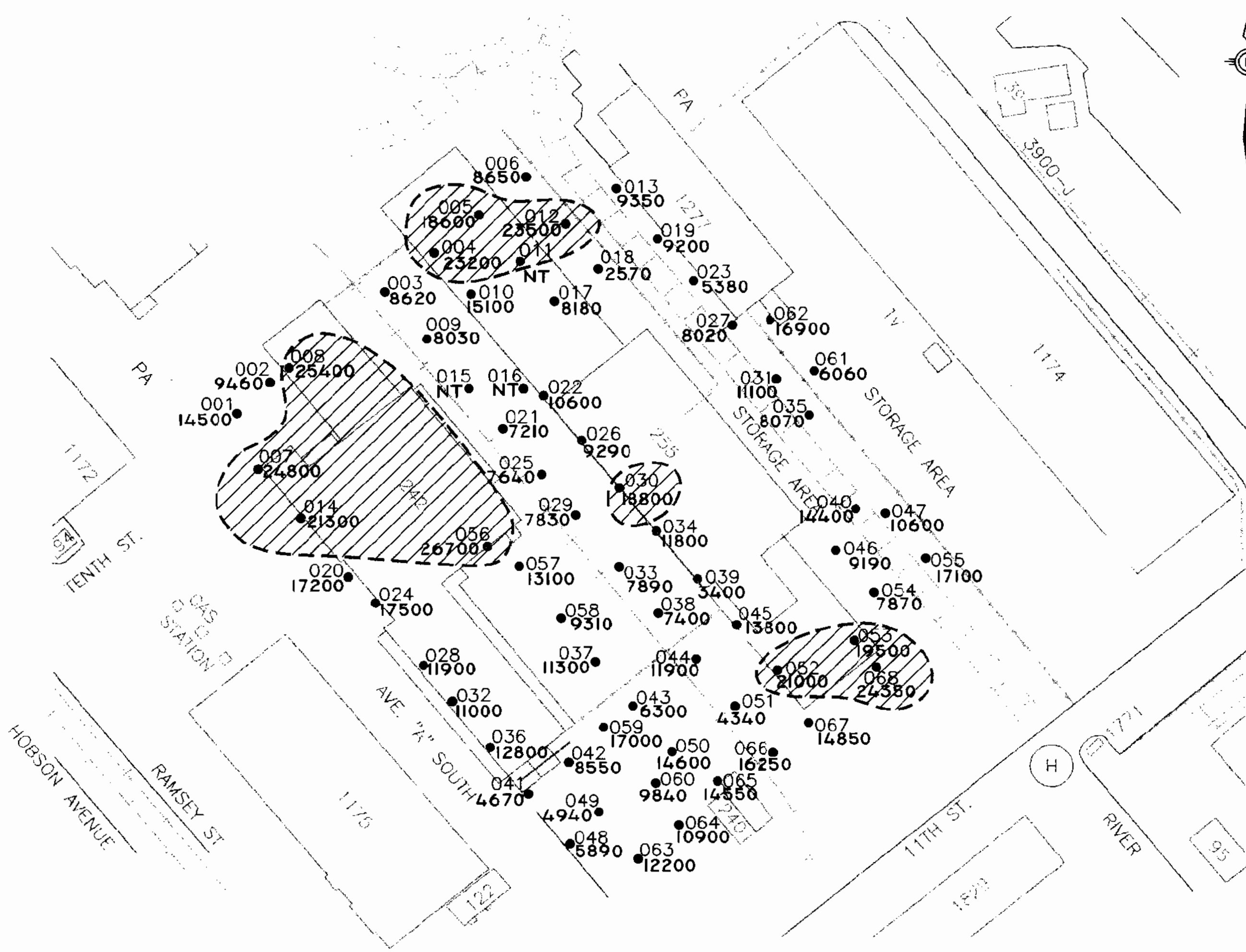
CHARLESTON, S.C.

FIGURE 10.7-16
VANADIUM IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 18 DEC 97 | DWG Name: 29FNEW09



LEGEND:

- • – DPT LOCATION
- <18500 mg/kg
- >18500 mg/kg
- APPROXIMATE EXTENT

NOTES:

18500 mg/kg = ZONE F BACKGROUND CONCENTRATION FOR ALUMINUM IN SURFACE SOIL.

THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.

ALL RESULTS IN mg/kg

NT = SAMPLE NOT TAKEN

100 0 100

SCALE IN FEET

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FIGURE 10.7-10
ALUMINUM IN SURFACE SOIL
AOC 613 & 615
AND SWMU 175

Date: 16 DEC 97 | DWG Name: 29FNEWC

Table 10.7.4a
Zone F
AOCs 613/615 and SWMU 175
Sediment Samples and Analyses

Boring Location	Sample Idenifier	Date Collected	Analyses	Remarks
613M0001	613M000101	9/27/96	Note 1	
	613N000101		Note 2	Duplicate Sample
613M0002	613M000201	9/27/96	Note 1	
613M0003	NA	NA	NA	Not Sampled

Notes:
1 = SW-846 (metals, SVOAs, VOAs); cyanides at DQO Level III
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample

Table 10.7.5
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)
Volatile Organic Compounds (μg/kg)			
Trichloroethene	1/2	2.00	2.00
Semivolatile Organic Compounds (μg/kg)			
B(a)P Equiv.	2/2	122 - 568	345
Acenaphthene	1/2	71.0	71.0
Anthracene	1/2	140	140
Benzo(a)anthracene	2/2	95.5 - 410	253
Benzo(a)pyrene	2/2	95.5-390	243
Benzo(b)fluoranthene	1/2	86.0	86.0
Benzo(g,h,i)perylene	2/2	81.0 - 220	151
Benzo(k)fluoranthene	2/2	140 - 610	375
Benzoic acid	1/2	51.0	51.0

Table 10.7.5
Zone F
AOC 613/615 and SWMU 175
Organic Compound Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)
Bis(2-ethylhexyl)phthalate	2/2	120 - 570	345
Butylbenzylphthalate	2/2	73.0 - 160	117
Chrysene	2/2	115 - 470	293
Di-n-butylphthalate	1/2	61.0	61.0
Dibenz(a,h)anthracene	1/2	110	110
Fluoranthene	2/2	200 - 1000	600
Fluorene	1/2	72.0	72.0
Indeno(1,2,3-cd)pyrene	2/2	68.5 - 200	134
Phenanthrene	2/2	109 - 520	315
Pyrene	2/2	165 - 880	523
Pesticides and PCBs (μg/kg)			
4,4'-DDE	1/1	10.0	10.0
Heptachlor epoxide	1/1	1.60	1.60
gamma-Chlordane	1/1	11.0	11.0
Dioxin (ng/kg)			
Dioxin (2,3,7,8-TCDD TEQ[1])	1/1	1.15	1.15

Notes:
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)

Table 10.7.6
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Sediment

Paramenters	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)
Inorganics (2 Samples Plus 1 Duplicate Sample) (mg/kg)			
Aluminum	2/2	3970 - 12200	8090
Arsenic	2/2	4.25 - 11.7	7.98
Barium	2/2	17.0 - 126	71.5
Cadmium	2/2	0.820 - 0.900	0.860
Calcium	2/2	35000 - 191000	113000
Chromium	2/2	19.0 - 27.3	23.1
Cobalt	2/2	3.20 - 3.35	3.28
Copper	1/2	58.6	58.6
Cyanide	1/2	1.10	1.10
Iron	2/2	6410 - 14000	10200
Lead	2/2	30.4 - 30.7	30.5
Magnesium	2/2	2840 - 23600	13200
Manganese	2/2	145 - 210	178
Mercury	1/2	0.0550	0.0550
Nickel	2/2	15.6 - 41.3	28.5
Potassium	2/2	577 - 658	617
Vanadium	2/2	13.1 - 28.1	19.6
Zinc	2/2	90.2 - 100	95.2

Table 10.7.7
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Volatile Organic Compounds (μg/kg)		
Trichloroethene	613M0002	2.0000
Semivolatile Organic Compounds (μg/kg)		
Acenaphthene	613M0002	71.0000
Anthracene	613M0002	140.0000
Benzo(a)anthracene	613M0001	95.5000
	613M0002	410.0000
Benzo(a)pyrene	613M0001	95.5000
	613M0002	390.0000
Benzo(b)fluoranthene	613M0001	86.0000
Benzo(g,h,i)perylene	613M0001	81.0000
	613M0002	220.0000
Benzo(k)fluoranthene	613M0001	140.0000
	613M0002	610.0000
Benzoic acid	613M0001	51.0000
bis(2-ethylhexyl)phthalate (BEHP)	613M0001	120.0000
	613M0002	570.0000
Butylbenzylphthalate	613M0001	160.0000
	613M0002	73.0000
Chrysene	613M0001	115.0000
	613M0002	470.0000
Dibenz(a,h)anthracene	613M0002	110.0000
Di-n-butylphthalate	613M0002	61.0000
Fluoranthene	613M0001	200.0000
	613M0002	1000.0000
Fluorene	613M0002	72.0000
Indeno(1,2,3-cd)pyrene	613M0001	68.5000
	613M0002	200.0000
Phenanthrene	613M0001	109.0000
	613M0002	520.0000

Table 10.7.7
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Pyrene	613M0001	165.0000
	613M0002	880.0000
Pesticides		
4,4'-DDE	613M0001	10.0000
Heptachlor epoxide	613M0001	1.6000
gamma-Chlordane	613M0001	11.0000
Inorganics (mg/kg)		
Aluminum (Al)	613M0001	3970.0000
	613M0002	12200.0000
Arsenic (As)	613M0001	4.2500
	613M0002	11.7000
Barium (Ba)	613M0001	17.0000
	613M0002	126.0000
Cadmium (Cd)	613M0001	0.9000
	613M0002	0.8200
Calcium (Ca)	613M0001	191000.0000
	613M0002	35000.0000
Chromium (Cr)	613M0001	18.9500
	613M0002	27.3000
Cobalt (Co)	613M0001	3.3500
	613M0002	3.2000
Copper (Cu)	613M0001	58.6000
Cyanide (CN)	613M0001	1.0950
Iron (Fe)	613M0001	6410.0000
	613M0002	14000.0000
Lead(Pb)	613M0001	30.6500
	613M0002	30.4000
Magnesium (Mg)	613M0001	2840.0000
	613M0002	23600

Table 10.7.7
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Sediment Samples

Parameters	Location	Concentration
Manganese (Mn)	613M0001	210.0000
	613M0002	145.0000
Mercury (Hg)	613M0001	0.0550
Nickel (Ni)	613M0001	15.6000
	613M0002	41.3000
Potassium (K)	613M0001	576.5000
	613M0002	658.0000
Vanadium (V)	613M0001	13.0500
	613M0002	26.1000
Zinc (Zn)	613M0001	100.2000
	613M0002	90.2000

The following sections discuss sediment sample analytical results relative to detected soil parameters as an indication of soil contaminant migration via storm water flow. Given that this sediment was collected from engineered structures (storm catch basins, storm water culverts, etc.), it is not true sediment generated in a native setting, and therefore, is not compared to reference concentrations or other criteria. The storm sewer system will be addressed in the Zone L RFI.

Volatile Organic Compounds in Sediment

Trichloroethene was the only VOC detected in sediment. This VOC was also detected in nine of the soil samples.

Semivolatile Organic Compounds in Sediment

Eighteen SVOCs were detected in sediment samples. Each of the compounds was also present in site soil samples.

Pesticides and PCBs in Sediment

Three pesticides, 4,4'-DDE, heptachlor epoxide and gamma-chlordane were detected in sediment samples. No pesticides were detected in soil samples at the combined site. PCBs were not detected in the duplicate sediment sample.

Other Organic Compounds in Sediment

Dioxin (2,3,7,8-TCDD TEQ') was detected in the duplicate sample. Dioxin was also detected in soil samples at the site.

Inorganic Elements in Sediment

Seventeen metals and cyanide were detected in sediment samples. Cyanide was the only analyte detected in sediment that was not detected in site soil samples.

10.7.5 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of three shallow and one deep monitoring well within the AOCs 613/615 and SWMU 175 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. Four shallow and one deep wells were actually installed. Shallow wells were installed at approximately 12-ft bgs in an upper sand layer of the Wando Formation. The deep well was installed to about 29-ft bgs. Nine existing shallow monitoring wells, installed during GEL's investigation of the AOCs 613/615 and SWMU 175 area were also included in the investigation (see Figure 10.7-2). In accordance with the approved final RFI work plan, groundwater samples were analyzed at DQO Level III for metals, SVOAs, and VOAs. Table 10.7.8 summarizes the groundwater samples and analyses at these sites.

Table 10.7.8
Zone F
AOCs 613/615 and SWMU 175
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
613001	Shallow	61300101*	11/20/96	Notes 1/2*	
61302D	Deep	61302D01	11/21/96	Note 1	
613003	Shallow	61300301	11/18/96	Note 1	
613004	Shallow	61300401	11/12/96	Note 1	
613005	Shallow	61300501	11/20/96	Note 1	
240003	Shallow	24000301	11/18/96	Note 1	
GEL005	Shallow	GEL00501	11/18/96	Note 1	
GEL006	Shallow	GEL00601	11/12/96	Note 1	
GEL007	Shallow	GEL00701	11/10/96	Note 1	
GEL008	Shallow	GEL00801	11/10/96	Note 1	
GEL011	Shallow	GEL01101	11/12/96	Note 1	
GEL012	Shallow	GEL01201*	11/12/96	Notes 1/2*	
GEL013	Shallow	GEL01301	11/12/96	Note 1	
GEL014	Shallow	GEL01401	11/12/96	Note 1	

Notes:
1 = SW-846 (metals, SVOAs, VOAs) at DQO Level III.
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV.
* = Duplicate sample collected.

10.7.5.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater are summarized in Table 10.7.9. Inorganic analytical results for groundwater are summarized in Table 10.7.10. Table 10.7.11 presents a summary of the analytes detected at the combined site.

Table 10.7.9
Zone F
AOC 613/615 and SWMU 175
Organic Analytical Results for Shallow and Deep Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Tap Water RBC* (μg/L	MCL/SMCL* (μg/kg)	Number of Samples Exceeding RBC
Volatile Organic Compounds (μg/kg)							
1,1-Dichloroethane	Shallow	1.13	2.00	2.00	81	NL	0
	Deep	0/1	ND	ND			0
1,2-Dichloroethene (total)	Shallow	3/13	2.00 - 24.0	9.67	5.5	70	1
	Deep	0/1	ND	ND			0
Benzene	Shallow	1/13	3800	3800	0.36	5	1
	Deep	0/1	ND	ND			0
Carbon disulfide	Shallow	1/13	1.000	1.000	100	NL	0
	Deep	1/1	3.000	3.000			0
Chloromethane	Shallow	1/13	2.00	2.00	1.4	NL	1
	Deep	0/1	ND	ND			0
Tetrachloroethene	Shallow	1/13	2.00	2.0	1.1	5.0	1
	Deep	0/1	ND	ND			0
Toluene	Shallow	3/13	1.000 - 4900	1630	75	1000	1
	Deep	1/1	24.0	24.0			0
Trichloroethene	Shallow	1/13	2.00	3.00	1.6	5.0	1
	Deep	0/1	ND	ND			0
Xylene (total)	Shallow	3/13	1.000 - 4.000	2.67	1200	1000	0
	Deep	0/1	ND	ND			0

Table 10.7.9
Zone F
AOC 613/615 and SWMU 175
Organic Analytical Results for Shallow and Deep Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Tap Water RBC* (μg/L	MCL/SMCL* (μg/kg)	Number of Samples Exceeding RBC
Semivolatile Organic Compounds (μg/kg)							
Acenaphthene	Shallow	1/13	210000	210000	220	NL	1
	Deep	0/1	ND	ND			0
Anthracene	Shallow	1/13	1.000	1.000	1100	NL	0
	Deep	0/1	ND	ND			0
Benzoic acid	Shallow	1/13	1.000 - 3.00	2.00	15000	NL	0
	Deep	0/1	1.000	1.000			0
bis(2-ethylhexyl)phthalate	Shallow	1/13	40000	40000	4.8	6	1
	Deep	0/1	ND	ND			0
Fluorene	Shallow	2/13	1.000 - 340000	170000	150	NL	1
	Deep	0/1	ND	ND			0
2-Methylnaphthalene	Shallow	1/13	2400000	2400000	150	NL	1
	Deep	0/1	ND	ND			0
Naphthalene	Shallow	1/13	3.00	3.00	150	NL	0
	Deep	0/1	ND	ND			0
Phenanthrene	Shallow	1/13	570000	570000	150	NL	1
	Deep	0/1	ND	ND			0
Pyrene	Shallow	1/13	24000	24000	110	NL	1
	Deep	0/1	ND	ND			0

Table 10.7.9
Zone F
AOC 613/615 and SWMU 175
Organic Analytical Results for Shallow and Deep Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Tap Water RBC* (μg/L	MCL/SMCL* (μg/kg)	Number of Samples Exceeding RBC
TPH							
Gasoline	Shallow	1/1	1950000	1950000	NL	NL	NA
	Deep	0/0	NA	NA	NA	NA	NA
Dioxin (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQ')	Shallow	1/2	0.306	0.306			
	Deep	0/0	NA	NA	NA	NA	NA

Notes:
NL = Not listed
NA = Not applicable
* = Tap water RBCs (THQ=0.1) and MCLs/SMCLs were used as reference concentrations.

Table 10.7.10
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Shallow and Deep Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Tap Water RBC* (μg/L)	MCL/SMCL* (mg/kg)	Number of Samples Exceeding RBCs
Inorganics(5 Deep Samples) (μg/L)							
Aluminum	Shallow	13/13	0.910 - 20000	4530	3700	50	3
	Deep	1/1	465	465			0
Antimony	Shallow	1/13	0.150	0.150	1.5	6	0
	Deep	0/1	ND	ND			0
Arsenic	Shallow	12/13	1.30 - 72.0	14.7	0.045	50	12
	Deep	1/1	4.70	4.70			1
Barium	Shallow	13/13	1.20 - 111	57.2	260	2000	0
	Deep	1/1	232	232			0
Beryllium	Shallow	2/13	1.80 - 1.90	1.85	0.016	4	2
	Deep	1/1	0.770	0.770			1
Cadmium	Shallow	3/13	0.300 - 2.70	1.31	1.8	5	1
	Deep	0/1	ND	ND			0
Calcium	Shallow	13/13	28.3 - 335000	130000	NL	NL	NA
	Deep	1/1	294000	294000			NA
Chromium	Shallow	8/13	0.270 - 42.7	12.6	18	100	2
	Deep	1/1	3.40	3.40			0
Cobalt	Shallow	7/13	2.00 - 104	28.2	220	NL	0
	Deep	0/1	ND	ND			0
Copper	Shallow	4/13	3.30 - 19.8	11.4	150	1000	0
	Deep	0/1	ND	ND			0

Table 10.7.10
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Shallow and Deep Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Tap Water RBC* (μg/L)	MCL/SMCL* (mg/kg)	Number of Samples Exceeding RBCs
Cyanide	Shallow	1/2	2.00	2.00	73	200	0
	Deep	0/0	ND	ND			0
Iron	Shallow	13/13	16.6 - 51500	23900	1100	300	12
	Deep	1/1	738	738			0
Lead	Shallow	8/13	2.00 - 33.3	11.1	15	15	2
	Deep	0/1	ND	ND			0
Magnesium	Shallow	13/13	1.80 - 362000	107000	NL	NL	NA
	Deep	1/1	814000	814000			NA
Manganese	Shallow	13/13	0.0700 - 6020	1310	84	50	12
	Deep	1/1	267	267			1
Mercury	Shallow	5/13	0.01000 - 0.240	0.134	1.1	2	0
	Deep	0/1	ND	ND			0
Nickel	Shallow	11/13	0.890 - 58.9	12.0	73	100	0
	Deep	1/1	3.20	3.20			0
Potassium	Shallow	12/13	2300 - 172000	45400	NL	NL	NA
	Deep	1/1	177000	177000			NA
Selenium	Shallow	6/13	0.800 - 5.90	3.97	18	50	0
	Deep	0/1	ND	ND			0
Sodium	Shallow	13/13	28.1 - 3630000	1090000	NL	NL	NA
	Deep	1/1	6150000	6150000			NA

Table 10.7.10
Zone F
AOC 613/615 and SWMU 175
Inorganic Analytical Results for Shallow and Deep Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Tap Water RBC* (μg/L)	MCL/SMCL* (mg/kg)	Number of Samples Exceeding RBCs
Thallium	Shallow	2/13	4.40 - 6.90	5.65	0.29	2	2
	Deep	0/1	ND	ND			0
Vanadium	Shallow	9/13	2.00 - 68.3	17.4	26	NL	NA
	Deep	1/1	4.20	4.20			NA
Zinc	Shallow	8/13	7.00 - 1440	209	1100	5000	1
	Deep	0/1	ND	ND			0

Notes:
* = Tap water RBCs (THQ=0.1) (USEPA, 1996b) and MCLs/SMCLs (USEPA, 1996d) were used as reference concentrations
NL = Not listed.
NA = Not applicable.

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Volatile Organic Compounds (µg/kg)							
1,1-Dichloroethane	GEL007	2	2	ND	81	NL	NA
1,2-Dichloroethene (total)	613004	24	39	35	5.5	70	NA
	GEL007	3	3	ND			
	GEL012	2	ND	ND			
Benzene	GEL014	3800	2	4	0.36	5	NA
Carbon disulfide	GEL012	1	ND	ND	100	NL	NA
	61302D	3	ND	9			NA
Chloromethane	GEL007	2	ND	ND	1.4	NL	NA
Tetrachloroethene	613004	2	3	ND	1.1	5.0	NA
	61302D	ND	2	ND			NA
	GEL014	ND	5	ND			NA
Toluene	GEL011	1	ND	ND	75	1000	NA
	GEL012	2	ND	ND			NA
	GEL014	4900	ND	ND			NA
	61302D	24	11	9			NA
Trichloroethene	613004	3	3	ND	1.6	5.0	NA
Vinyl chloride	613004	ND	7	ND	0.019	2	NA
Xylene (total)	613003	1.0	ND	ND	1200	10000	NA
	GEL008	4.0	ND	ND			NA
	GEL011	3.0	ND	ND			NA
Semivolatile Organic Compounds (µg/L)							
2-Chlorophenol	61302D	ND	ND	2	18	NL	NA
	GEL013	ND	ND	2			NA

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (μg/L)	MCL/SMCLs* (μg/L)	Background
2-Methylnaphthalene	GEL005	ND	4	ND	150	NL	NA
	GEL014	2400000	44	590			NA
4-Chloro-3-methylphenol	GEL013	ND	ND	2	NL	NL	NA
Acenaphthene	GEL013	ND	ND	2	220	NL	NA
	GEL014	210000	ND	83			
Anthracene	613003	1	ND	ND	1100	NL	NA
Benzoic acid	GEL005	2	ND	ND	15000	NL	NA
	GEL007	1	ND	ND			
	GEL008	3	ND	6			
	GEL012	ND	ND	6			
	GEL013	ND	ND	4			
	61302D	1	ND	ND			
bis(2-ethylhexyl)phthalate	GEL014	4000	ND	75	4.8	6	NA
Butylbenzylphthalate	GEL013	ND	ND	2	730	NL	NA
Dibenzofuran	GEL014	ND	4	ND	15	NL	NA
Diethylphthalate	613001	ND	ND	1	2900	NL	NA
	GEL013	ND	ND	1			
Di-n-butylphthalate	613001	ND	ND	1	370	NL	NA
	GEL005	ND	ND	2			NA
	GEL008	ND	1	ND			NA
	GEL011	ND	ND	2			NA
	GEL012	ND	ND	1			NA
	GEL013	ND	ND	1			NA
Fluorene	613003	1	ND	ND	150	NL	NA
	GEL014	34000	8	140			NA

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (μg/L)	MCL/SMCLs* (μg/L)	Background
Naphthalene	613001	ND	2	ND	150	NL	NA
	GEL005	3	ND	ND			
Pentachlorophenol	GEL013	ND	ND	2	0.56	1	NA
Phenanthrene	GEL014	570000	11	210	150	NL	NA
Pyrene	GEL005	ND	ND	0.6	110	NL	NA
	GEL013	ND	ND	1.0			NA
	GEL014	2400	ND	ND			NA
TPH							
Gasoline	GEL014	1950000	NT	NT	NL	NL	NA
Dioxin (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQ')	613SP001	0.0361	1000	NA	ND	1900	NA
Inorganics (μg/L)							
Aluminum (Al)	240003	803.00	ND	158.00	3700	50	224
	613001	3585.00	2100.0	2010.00			
	613003	472.00	ND	161.00			
	613004	3640.00	267.0	ND			
	613005	549.00	322.0	404.00			
	GEL005	**6500.00**	316.0	2180.00			
	GEL006	831.00	198.0	107.00			
	GEL007	2590.00	ND	ND			
	GEL008	**20000.00**	289.0	ND			
	GEL011	**17000.00**	58.3	ND			
	GEL012	679.00	141.0	270.00			
	GEL013	2190.00	379.0	129.00			
	GEL014	0.91	391.0	ND			
	61302D	465.00	ND	ND			77.7

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Antimony (Sb)	613001	ND	ND	2.80	1.5	6	NL
	613004	ND	**2.00**	ND			
	GEL008	ND	**2.90**	ND			
	GEL011	ND	**3.60**	ND			
	GEL012	ND	**3.90**	ND			
	GEL013	ND	**2.80**	ND			
	GEL014	0.15	**4.60**	ND			
Arsenic (As)	240003	7.80	9.40	ND	0.045	50	16.7
	613004	2.50	2.90	ND			
	613003	5.80	3.90	ND			
	613004	3.30	3.30	ND			
	613005	9.90	**27.10**	**44.7**			
	GEL005	**23.10**	3.10	ND			
	GEL007	**72.00**	**23.00**	9.70			
	GEL008	**20.30**	ND	ND			
	GEL011	14.30	4.70	4.00			
	GEL012	2.95	ND	ND			
	GEL013	13.20	10.50	12.40			
	GEL014	1.30	**60.70**	**60.60**			
	61302D	4.70	ND	ND			

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (μg/L)	MCL/SMCLs* (μg/L)	Background
Barium (Ba)	240003	66.30	60.20	53.5	260	2000	94.3
	613001	71.65	54.80	73.45			
	613001	25.20	21.10	31.40			
	613004	76.80	38.10	37.60			
	613005	32.00	24.80	25.70			
	GEL005	52.90	32.20	46.10			
	GEL006	23.80	30.60	30.30			
	GEL007	111.00	150.00	146.00			
	GEL008	79.50	39.10	16.10			
	GEL011	107.00	57.30	46.10			
	GEL012	40.90	34.45	40.80			
	GEL013	55.20	53.20	55.10			
	GEL014	1.20	18.20	17.00			
	61302D	232.00	223.00	234.00			200
Beryllium (Be)	613001	**1.90**	**2.00**	**2.00**	0.016	4	0.66
	613004	ND	ND	0.43			
	GEL008	**1.80**	ND	ND			
	GEL011	ND	0.29	MD			
	GEL012	ND	0.23	MD			
	GEL013	ND	0.26	MD			
	61302D	**0.77**	ND	**1.60**			0.46
Cadmium (Cd)	613001	0.935	**1.80**	**1.85**	1.8	5	0.82
	613003	ND	0.31	ND			
	613005	ND	0.35	0.46			
	GEL007	ND	0.35	1.20			
	GEL011	**2.70**	0.40	ND			
	GEL014	0.30	0.68	ND			

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (μg/L)	MCL/SMCLs* (μg/L)	Background
Calcium (Ca)	240003	58200	56000	51600	NL	NL	NL
	613001	335000	334000	409500			
	613003	176000	176000	164000			
	613004	78000	61000	50200			
	613005	153000	101000	111000			
	GEL005	73700	114000	100000			
	GEL006	22300	9050	24400			
	GEL007	121000	182000	415000			
	GEL008	195000	161000	152000			
	GEL011	242000	210000	184000			
	GEL012	34550	29150	39850			
	GEL013	198000	185000	183000			
	GEL014	28.3	42700	33100			
	61302D	294000	274000	270000			NL
Chromium (Cr)	613003	1.70	1.20	ND	18	100	2.05
	613004	6.00	1.30	ND			
	613005	1.40	1.90	ND			
	GEL005	11.90	1.90	5.50			
	GEL007	4.50	ND	ND			
	GEL008	42.70	3.60	1.50			
	GEL011	32.30	2.00	1.00			
	GEL012	ND	ND	1.20			
	GEL013	ND	2.40	1.10			
	GEL014	0.27	2.30	1.40			
	61302D	3.40	2.10	1.30			1.31

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Cobalt (Co)	613001	104.00	108.00	132.00	220	NL	10.9
	613003	ND	1.40	2.60			
	613004	2.00	7.30	5.90			
	613005	18.10	5.30	6.20			
	GEL006	ND	ND	1.40			
	GEL007	10.80	22.40	83.40			
	GEL008	6.40	ND	1.80			
	GEL011	48.70	49.80	40.90			
	GEL012	7.10	7.05	10.15			
	GEL013	ND	0.98	ND			
	GEL014	ND	2.30	1.80			
	61302D	ND	ND	1.20			67.0
Copper (Cu)	613003	ND	4.2	ND	1.50	1000	ND
	GEL005	7.40	ND	ND			
	GEL008	15.00	1.4	ND			
	GEL011	19.80	ND	ND			
	GEL014	3.30	6.6	2.80			
	61302D	ND	ND	2.20			NL
Cyanide (CN)	GEL012	2.00	NT	NT	73	200	3.3

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Iron (Fe)	240003	**20500**	**26200**	**17000**	1100	300	NL
	613001	**51450**	**53450**	**50600**			
	613003	**42100**	**13300**	**25200**			
	613004	**5960**	**7460**	**7670**			
	613005	38600	**35500**	**47400**			
	GEL005	12500	551	**2270**			
	GEL006	3100	**2940**	**3110**			
	GEL007	20400	**13100**	**26200**			
	GEL008	40200	**18500**	**4050**			
	GEL011	48300	**31100**	**24100**			
	GEL012	10060	**8635**	**10650**			
	GEL013	18000	**11300**	**7520**			
	GEL015	16.6	**20600**	**18200**			
	61302D	738	ND	ND			
Lead (Pb)	613001	2.00	ND	ND	15	15	NL
	613004	3.50	ND	ND			
	GEL005	8.80	ND	ND			
	GEL007	2.70	ND	ND			
	GEL008	**33.30**	ND	ND			
	GEL011	**30.80**	1.30	ND			
	GEL012	ND	1.20	ND			
	GEL013	2.90	ND	ND			
	GEL014	4.60	3.90	ND			

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (μg/L)	MCL/SMCLs* (μg/L)	Background
Magnesium (Mg)	240003	28200	25000	22900	NL	NL	NL
	613001	184500	176000	211500			
	613003	65700	32000	44200			
	613004	26000	22100	19800			
	613005	270000	218000	21000			
	GEL005	31200	21100	24400			
	GEL006	2720	2870	4120			
	GEL007	26300	41100	95600			
	GEL008	362000	274000	248000			
	GEL011	211000	188000	146000			
	GEL012	25750	23100	30900			
	GEL013	164000	329000	54200			
	GEL014	1.8	14900	15700			
	61302D	814000	745000	594000			NL
Manganese (Mn)	240003	179.00	196.00	156.00	84	50	2010
	613001	**6020.00**	**6350.00**	**7740.00**			
	613003	**4050.00**	1390.00	**3010.00**			
	613004	428.00	405.00	351.00			
	613005	672.00	404.00	415.00			
	GEL005	274.00	302.00	304.00			
	GEL006	51.20	40.00	69.70			
	GEL007	827.00	1430.00	**4040.00**			
	GEL008	**2120.00**	**2020.00**	1760.00			
	GEL011	1300.00	1290.00	1060.00			
	GEL012	201.50	183.00	252.00			
	GEL013	923.00	962.00	745.00			
	GEL014	0.07	282.00	235.00			
	61302D	267.00	175.00	162.00			1256

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (μg/L)	MCL/SMCLs* (μg/L)	Background
Mercury (Hg)	240003	ND	ND	0.11	1.1	2	NL
	613004	0.24	ND	ND			
	613005	ND	0.10	0.14			
	GEL008	0.15	0.11	ND			
	GEL011	0.12	ND	ND			
	GEL012	0.15	ND	ND			
	GEL014	0.01	ND	ND			
	61302D	ND	0.13	0.14			
Nickel (Ni)	613001	58.85	54.05	64.75	73	100	5.55
	613003	2.20	1.60	ND			
	613004	2.90	2.90	2.70			
	613005	9.40	ND	ND			
	GEL005	ND	ND	3.60			
	GEL006	1.30	ND	2.00			
	GEL007	10.70	11.30	26.60			
	GEL008	12.60	4.30	2.70			
	GEL011	26.70	18.60	15.60			
	GEL012	4.10	3.55	5.00			
	GEL013	2.40	2.70	2.90			
	GEL014	0.89	2.70	1.80			
	61302D	3.20	ND	ND			61.1

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Potassium (K)	240003	32500.00	27300.00	28400.00	NL	NL	NL
	613001	10750.00	860.00	12400.00			
	613003	48100.00	23700.00	41800.00			
	613004	176300.00	11400.00	15700.00			
	613005	85300.00	75300.00	88600.00			
	GEL005	35200.00	17800.00	28500.00			
	GEL006	2300.00	2750.00	3690.00			
	GEL007	4450.00	5290.00	9920.00			
	GEL008	172000.00	107000.00	121000.00			
	GEL011	37600.00	45400.00	65200.00			
	GEL012	6690.00	5245.00	8195.00			
	GEL013	92700.00	112000.00	47200.00			
	GEL014	ND	16100.00	19300.00			
	61302D	177000.00	168000.00	188000.00			NL
Selenium (Se)	613004	4.70	ND	ND	18	50	NL
	GEL006	3.60	ND	ND			
	GEL008	ND	4.40	ND			
	GEL011	5.70	ND	ND			
	GEL012	3.10	MD	ND			
	GEL013	5.90	MD	ND			
	GEL014	0.80	4.90	ND			

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Sodium (Na)	240003	258000	215000	222000	NL	NL	NL
	613001	1470000	1450000	1520000			
	613003	250000	149000	268000			
	613004	517000	482000	530000			
	613005	3630000	3130000	3870000			
	GEL005	472000	172000	262000			
	GEL006	158000	158000	193000			
	GEL007	472000	532000	1100000			
	GEL008	2920000	2170000	2590000			
	GEL011	2210000	1960000	1760000			
	GEL012	506000	446500	615000			
	GEL013	1270000	2600000	302000			
	GEL014	28.1	89200	146000			
	61302D	6150000	5080000	6230000			NL
Thallium (Tl)	240003	ND	**8.60**	ND	0.29	2	5.58
	613001	ND	**9.05**	ND			
	613004	ND	**7.60**	ND			
	613005	ND	**6.60**	ND			
	GEL006	ND	5.30	ND			
	GEL007	4.40	**8.10**	ND			
	GEL008	**6.90**	ND	ND			
	61302D	ND	5.50	ND			8.18

Table 10.7.11
Zone F
AOC 613/615 and SWMU 175
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc/	Tap Water RBC* (µg/L)	MCL/SMCLs* (µg/L)	Background
Vanadium (V)	240003	ND	ND	1.30	26	NL	1.58
	613001	ND	1.90	2.25			
	613003	ND	1.90	5.10			
	613004	8.20	1.30	ND			
	613005	ND	1.10	1.20			
	GEL005	23.60	8.70	15.80			
	GEL006	2.00	ND	ND			
	GEL007	5.60	1.20	ND			
	GEL008	68.30	3.20	11.10			
	GEL011	30.00	ND	ND			
	GEL012	2.20	ND	1.10			
	GEL013	11.10	5.90	6.50			
	GEL014	5.20	4.30	4.20			
	61302D	4.20	1.3	ND			1.13
Zinc (Zn)	613001	102.50	93.85	108.50	1100	5000	NL
	613003	ND	9.00	ND			
	613004	16.90	ND	8.90			
	613005	ND	13.60	ND			
	GEL005	12.80	ND	22.80			
	GEL006	65.00	ND	8.60			
	GEL007	ND	ND	26.40			
	GEL008	ND	ND	9.50			
	GEL011	1440	ND	35.70			
	GEL012	16.75	ND	15.80			
	GEL013	15.00	ND	20.40			
	GEL014	7.00	ND	21.20			
pH							
pH	619001	NT	5.75	NT	NL	NL	NL

Notes:

*	=	Tap water RBCs (THQ=0.1) and MCLs/SMCLs were used as reference concentrations
NT	=	Not taken
NL	=	Not listed
NA	=	Not applicable

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.

All background reference values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background reference values for groundwater are based on two sampling rounds in two wells at each depth.

Volatile Organic Compounds in Groundwater

None VOCs were detected in groundwater samples during the initial groundwater sampling event, six of these VOCs exceeded their respective tap water RBCs. 1,2-dichloroethene (total), benzene, chloromethane, tetrachloroethene, toluene, and trichloroethene all exceeded their respective tap water RBC. No VOCs were exceeded in the deep well sample during the initial sampling. Figures 10.7-16a through 10.7-21 illustrate the VOCs detected during the initial groundwater sampling that exceeded their respective tap water RBCs.

Semivolatile Organic Compounds in Groundwater

Nine SVOCs were detected in groundwater samples during initial sampling event. Six of these SVOCs exceeded their respective tap water RBCs in the shallow groundwater sample from GEL014. 2-methylnapthalene, acenaphthene, bis(2-ethylhexyl)phthalate, fluorene, phenanthrene, and pyrene each exceeded their respective tap water RBCs. Benzoic acid was detected in the deep well sample far below its RBC. Figures 10.7-22 through 10.7-27 illustrate the distribution of SVOCs detected during the initial groundwater sampling that exceeded their respective tap water RBCs.

Inorganic Elements in Groundwater

Twenty-two metal and cyanide were detected in AOC 613/615 and SWMU 175 groundwater samples during the initial sampling event. Aluminum, arsenic, beryllium, cadmium, chromium, lead, manganese, thallium, and vanadium exceeded both their respective tap water RBCs and shallow groundwater background concentrations. In the deep groundwater sample beryllium exceeded its RBC and the deep groundwater background concentration. Iron, lead and zinc exceeded their RBCs, but no background is available for these metals in Zone F groundwater. Figures 10.7-28 through 10.7-37 illustrate the distribution of these metals detected during the initial groundwater sampling that exceeded both their respective tap water RBCs and background concentrations.

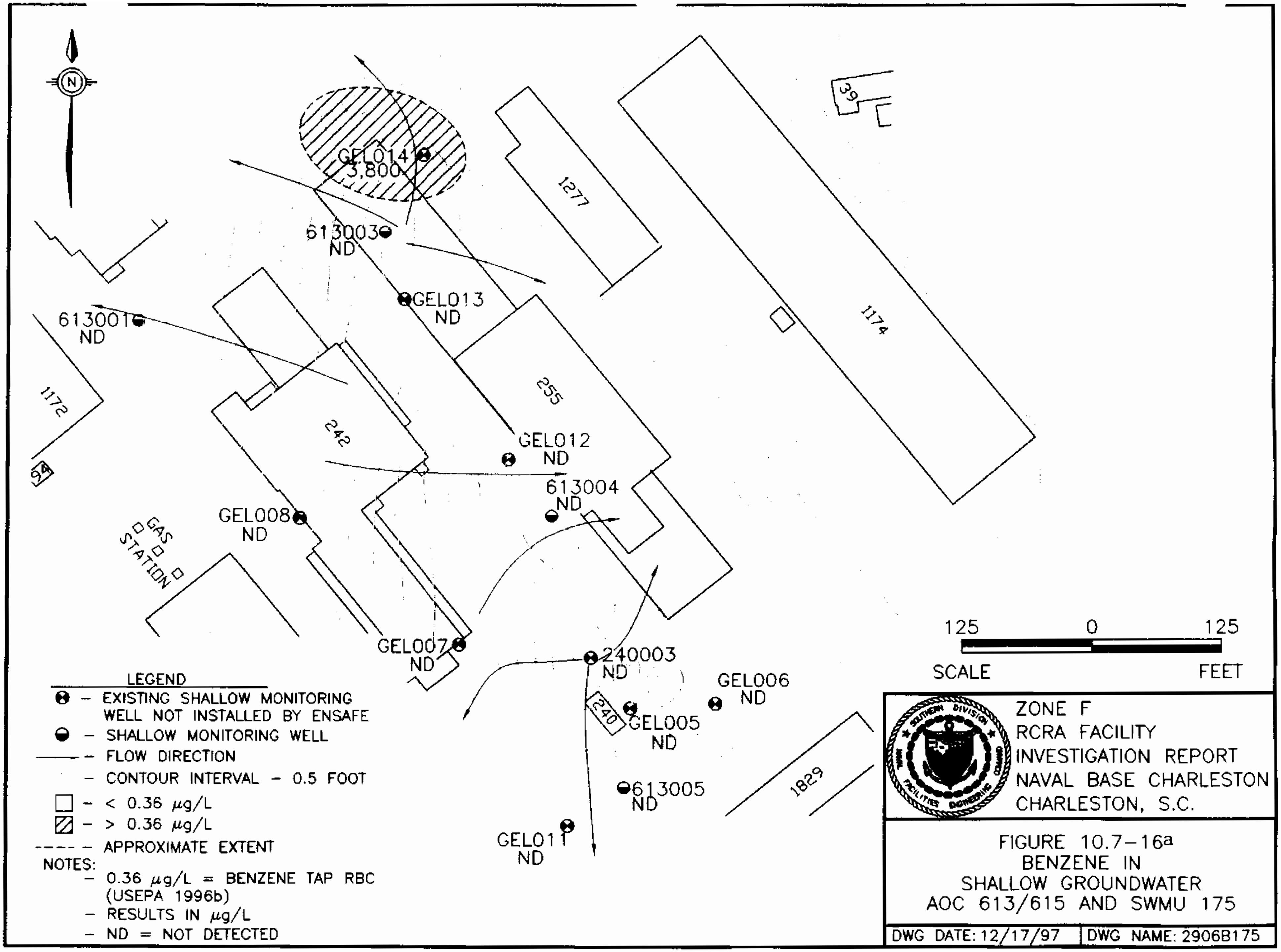


FIGURE 10.7–16a
BENZENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175

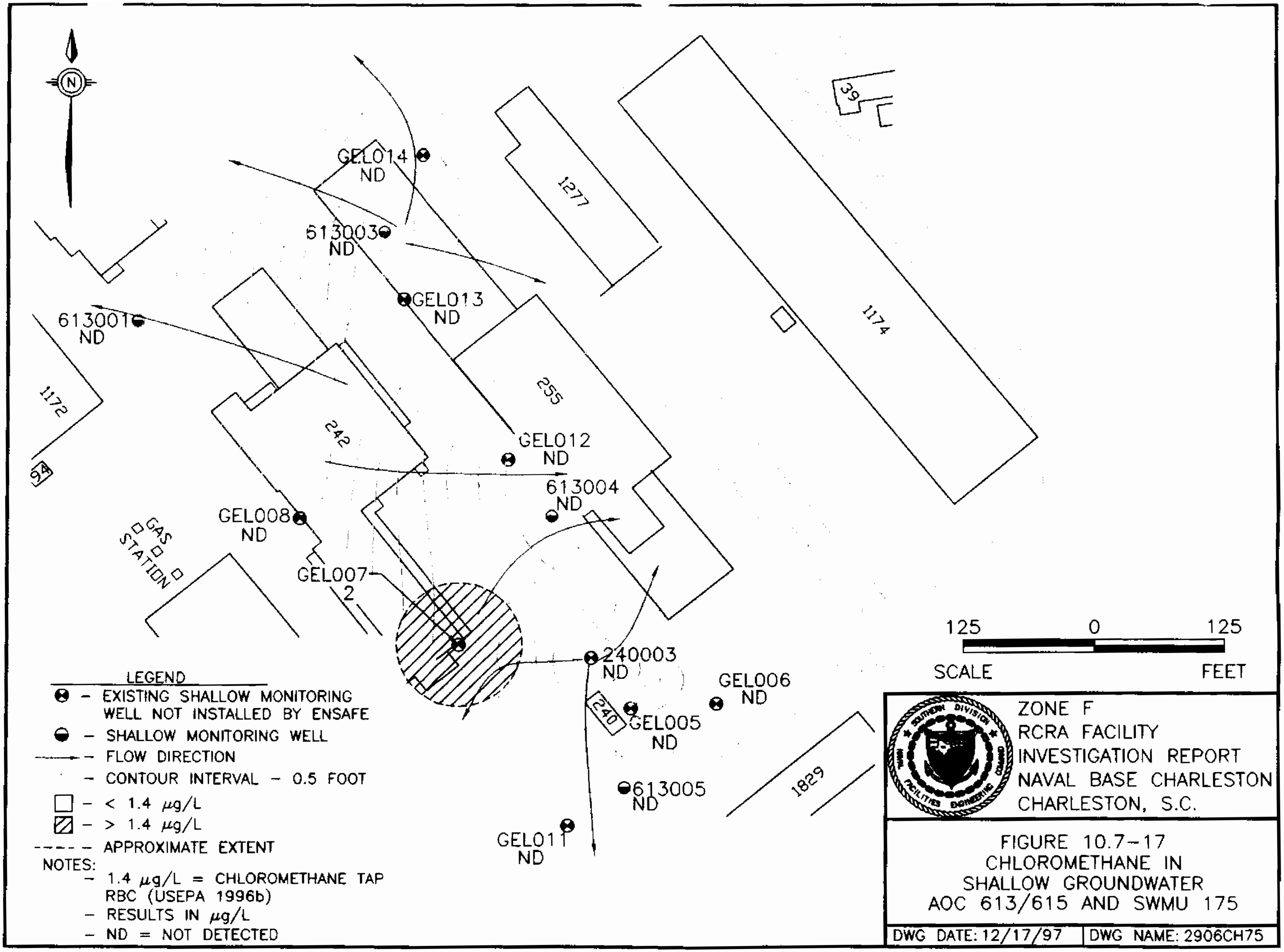
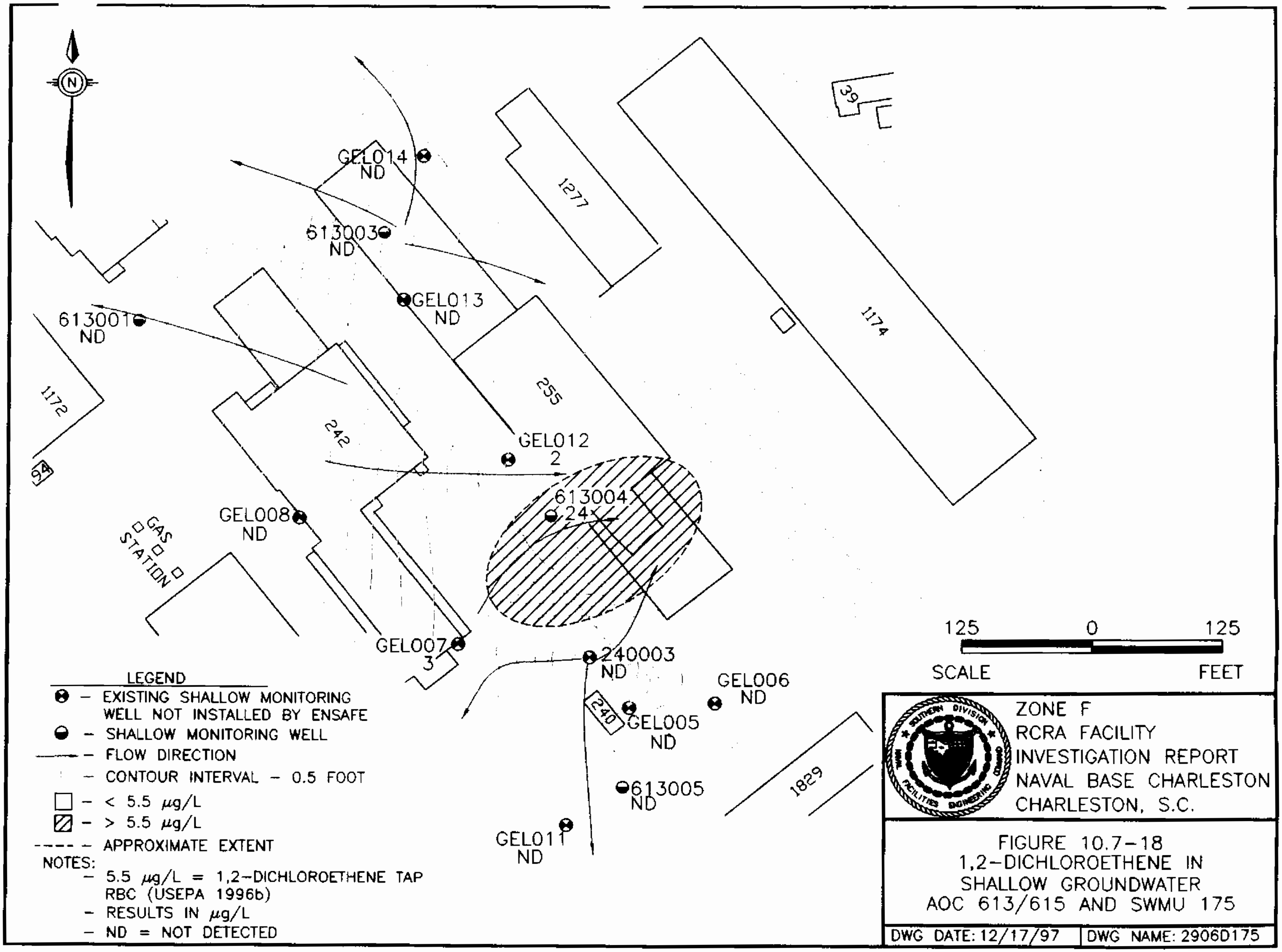


FIGURE 10.7–17
CHLOROMETHANE IN SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175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613003
ND
GEL013
ND
613001
ND
1277
1174
39
1172
255
242
94
GEL012
2
613004
24
GEL008
ND
GAS
STATION
GEL007
3
240003
ND
GEL006
ND
240
GEL005
ND
613005
ND
GEL011
ND
1829
125
0
125
SCALE
FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 5.5 μg/L
– > 5.5 μg/L
– APPROXIMATE EXTENT
NOTES:
– 5.5 μg/L = 1,2-DICHLOROETHENE TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-18
1,2-DICHLOROETHENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906D175

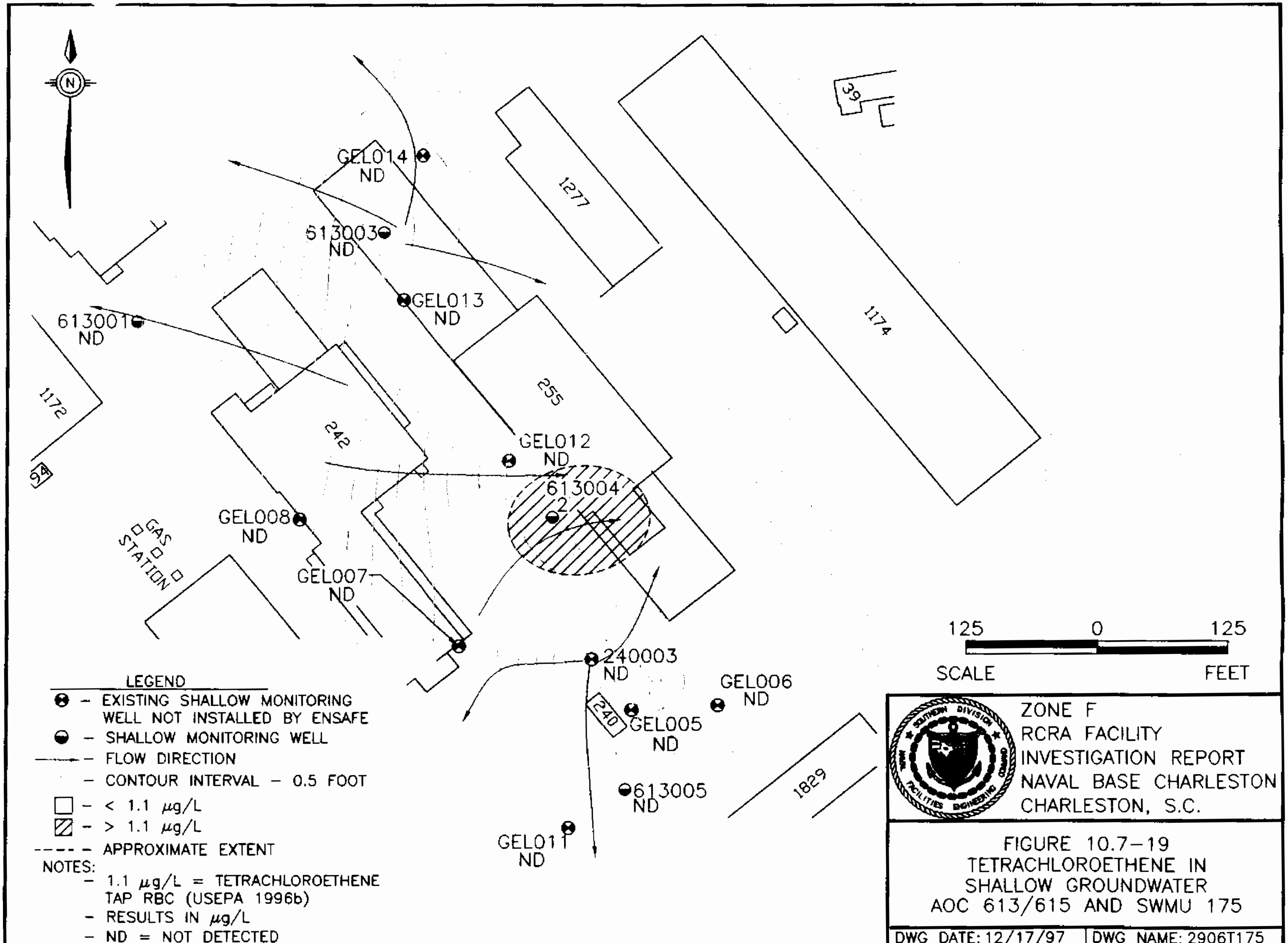

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FIGURE 10.7–19
TETRACHLOROETHENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175

DWG DATE: 12/17/97 | DWG NAME: 2906T175

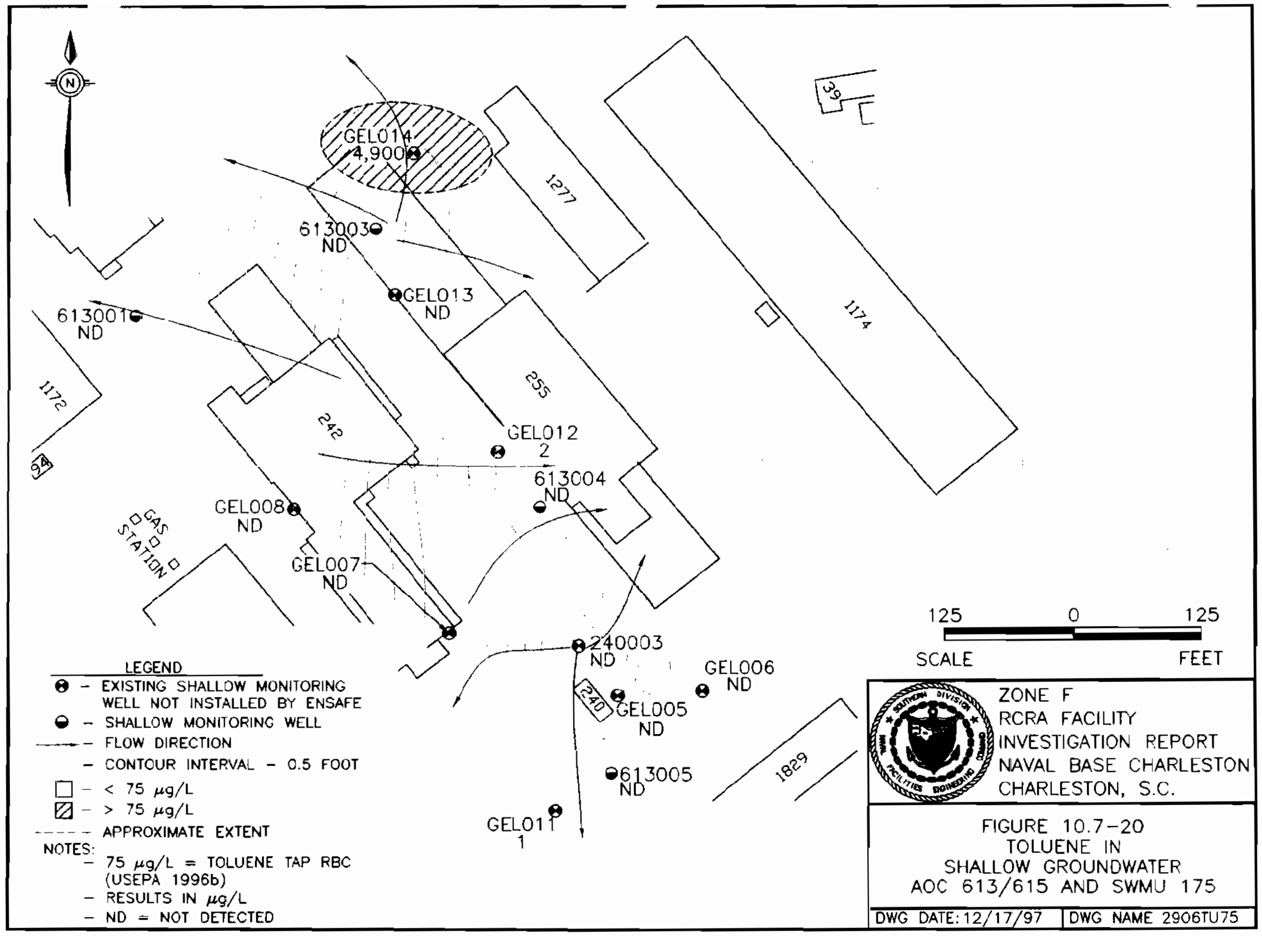
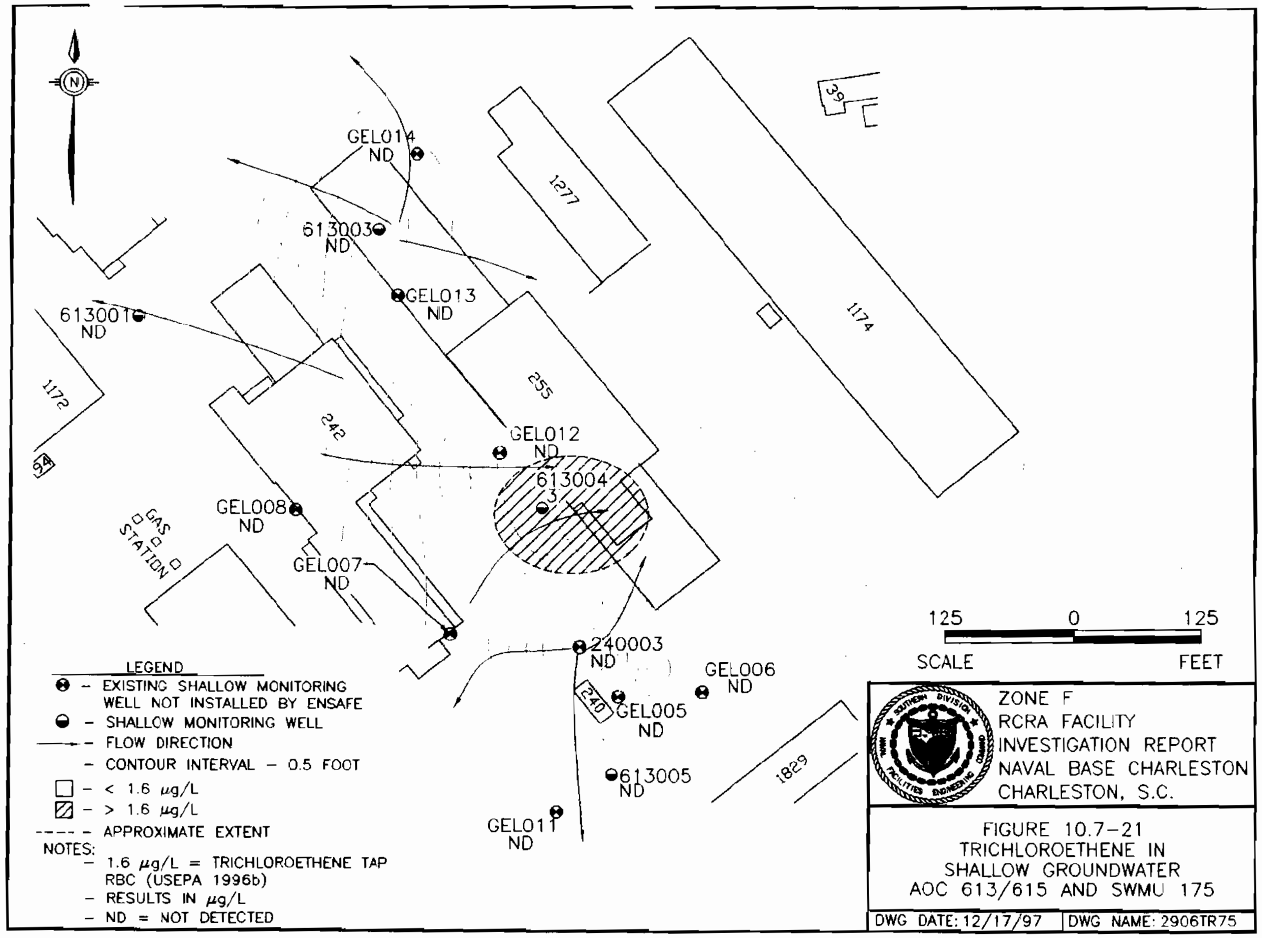
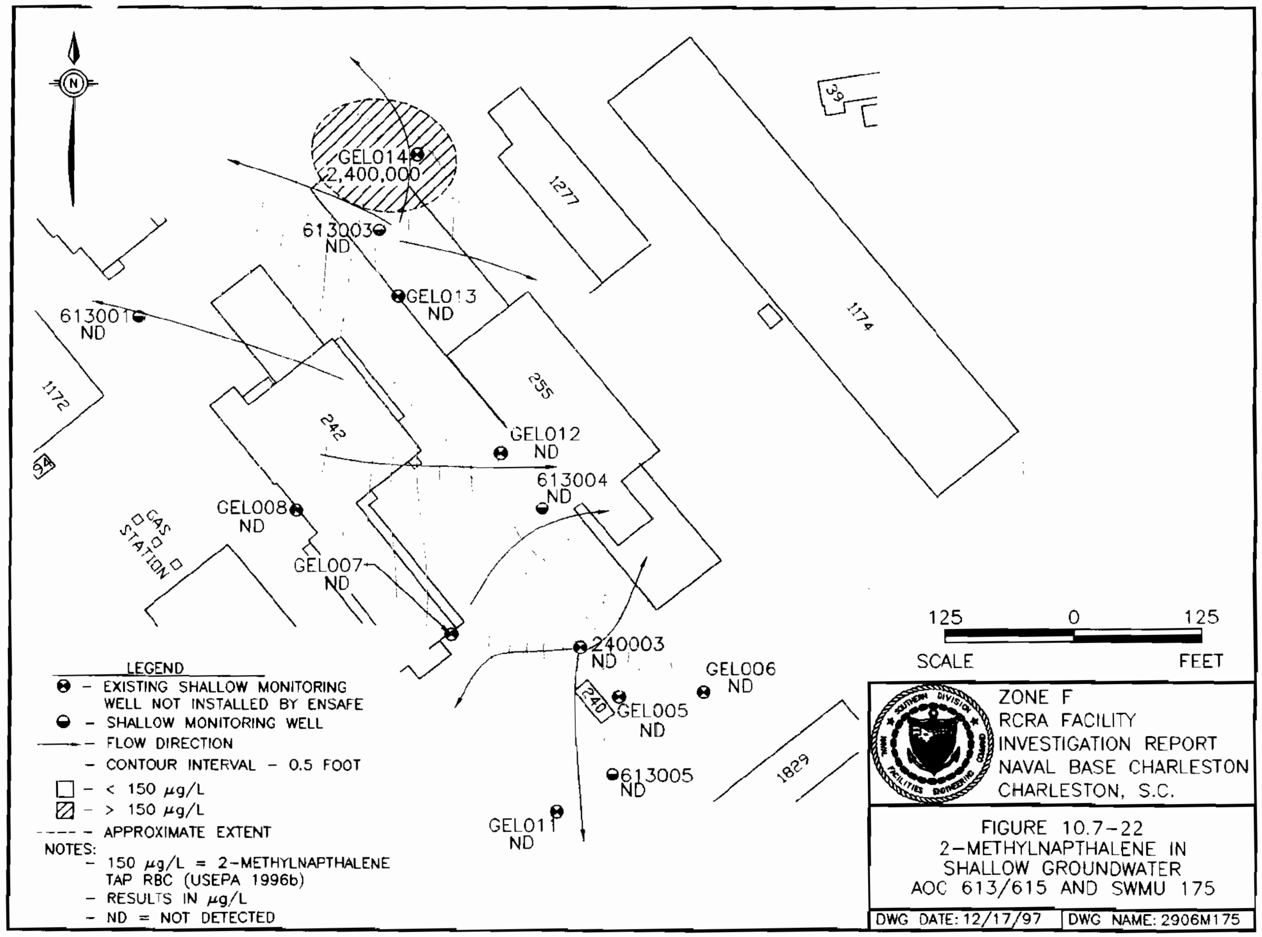


FIGURE 10.7-20
TOLUENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175



N
GEL014
ND
613003
ND
GEL013
ND
613001
ND
1277
1174
39
1172
255
242
GEL012
ND
613004
3
94
GEL008
ND
GAS STATION
GEL007
ND
240003
ND
GEL006
ND
240
GEL005
ND
613005
ND
1829
GEL011
ND
125
0
125
SCALE
FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 1.6 μg/L
– > 1.6 μg/L
– APPROXIMATE EXTENT
NOTES:
– 1.6 μg/L = TRICHLOROETHENE TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7–21
TRICHLOROETHENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906TR75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613003
ND
GEL013
ND
613001
ND
1172
54
1277
1174
39
255
242
GEL012
ND
613004
ND
GEL008
ND
GAS STATION
GEL007
ND
240003
ND
GEL006
ND
240
GEL005
ND
613005
ND
GEL011
ND
1829
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 150 μg/L
– > 150 μg/L
– APPROXIMATE EXTENT
NOTES:
– 150 μg/L = 2-METHYLNAPTHALENE TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-22
2-METHYLNAPTHALENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906M175

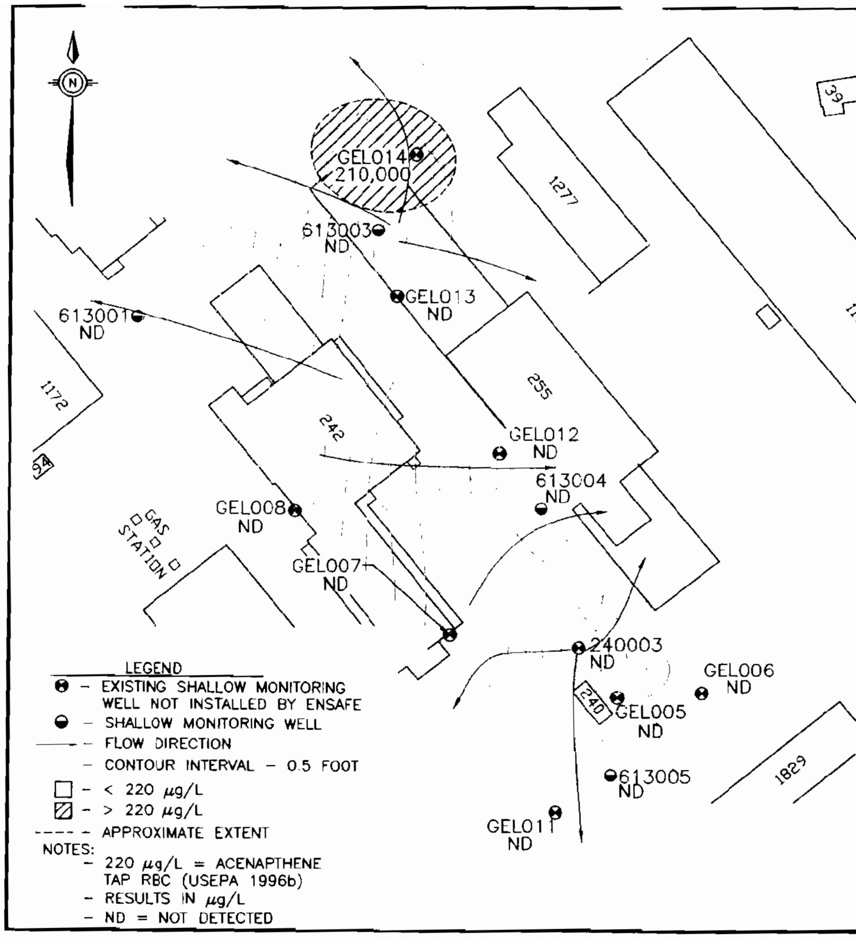

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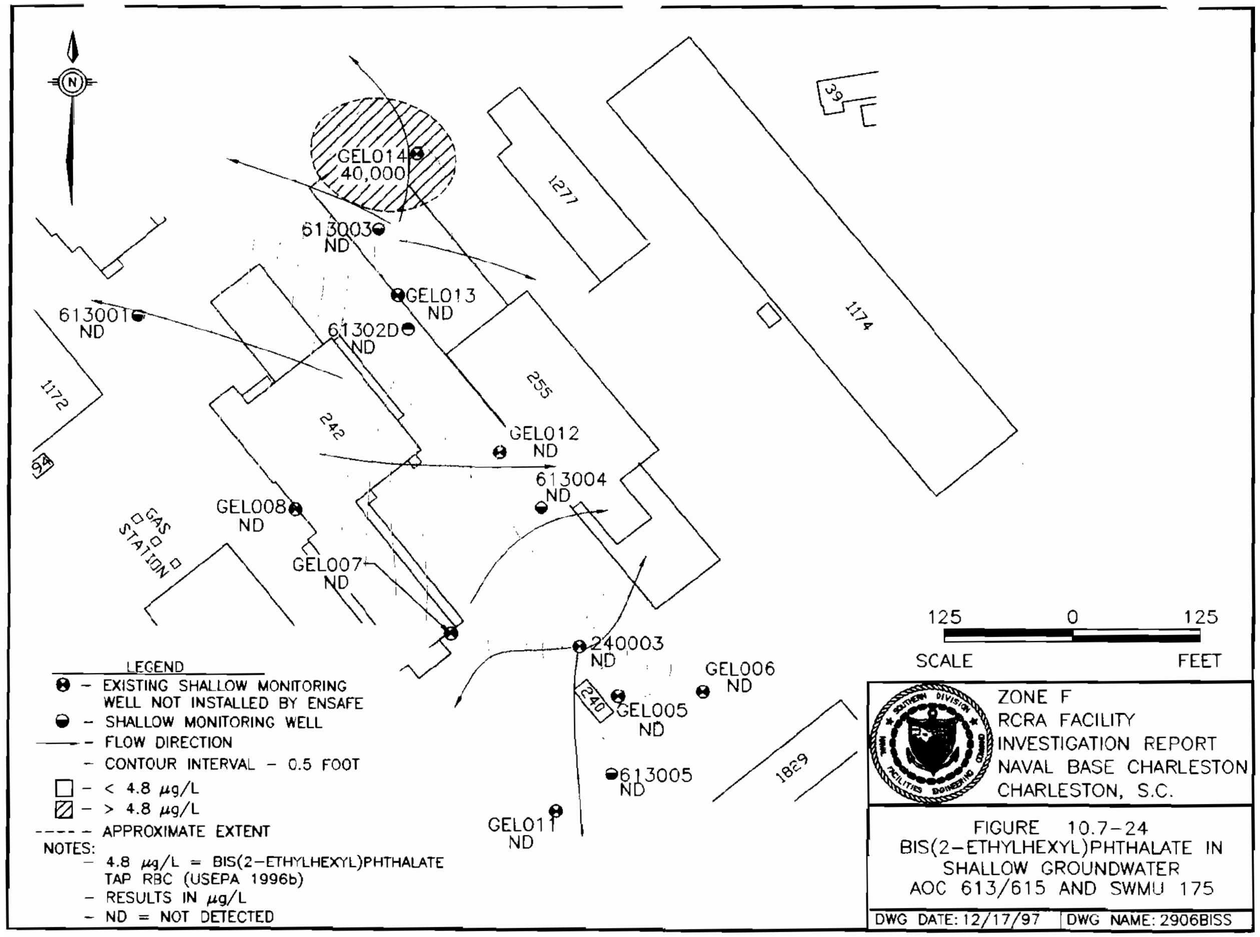
FIGURE 10.7-23
ACENAPTHENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175

DWG DATE: 12/17/97 | DWG NAME: 2906A175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613003
ND
GEL013
ND
613001
ND
61302D
ND
1277
1174
255
242
1172
54
GEL012
ND
613004
ND
GEL008
ND
GAS STATION
GEL007
ND
240003
ND
GEL006
ND
240
GEL005
ND
613005
ND
GEL011
ND
1829
39
125
0
125
SCALE
FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 4.8 μg/L
– > 4.8 μg/L
– APPROXIMATE EXTENT
NOTES:
– 4.8 μg/L = BIS(2-ETHYLHEXYL)PHTHALATE TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-24
BIS(2-ETHYLHEXYL)PHTHALATE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906BISS

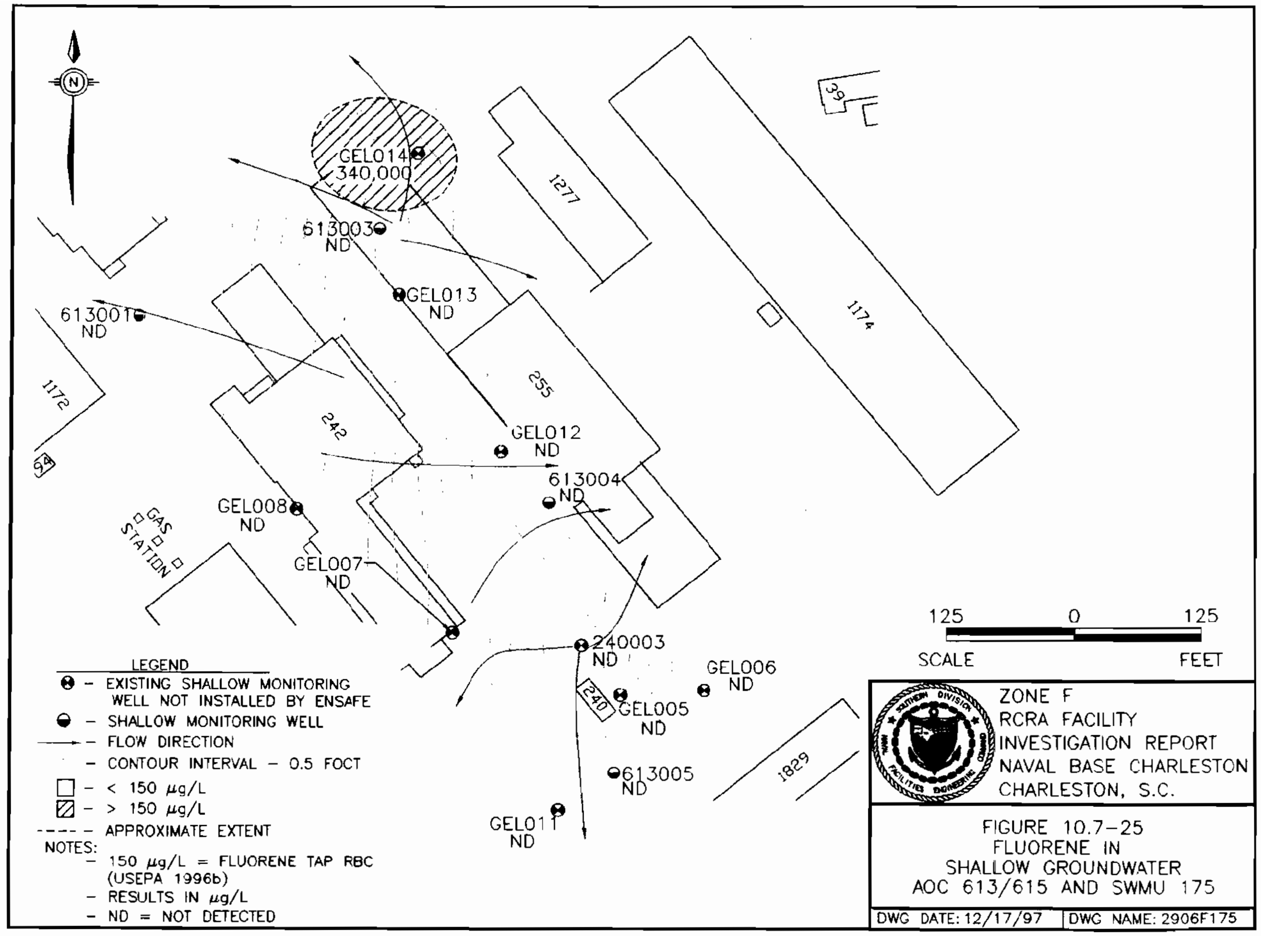
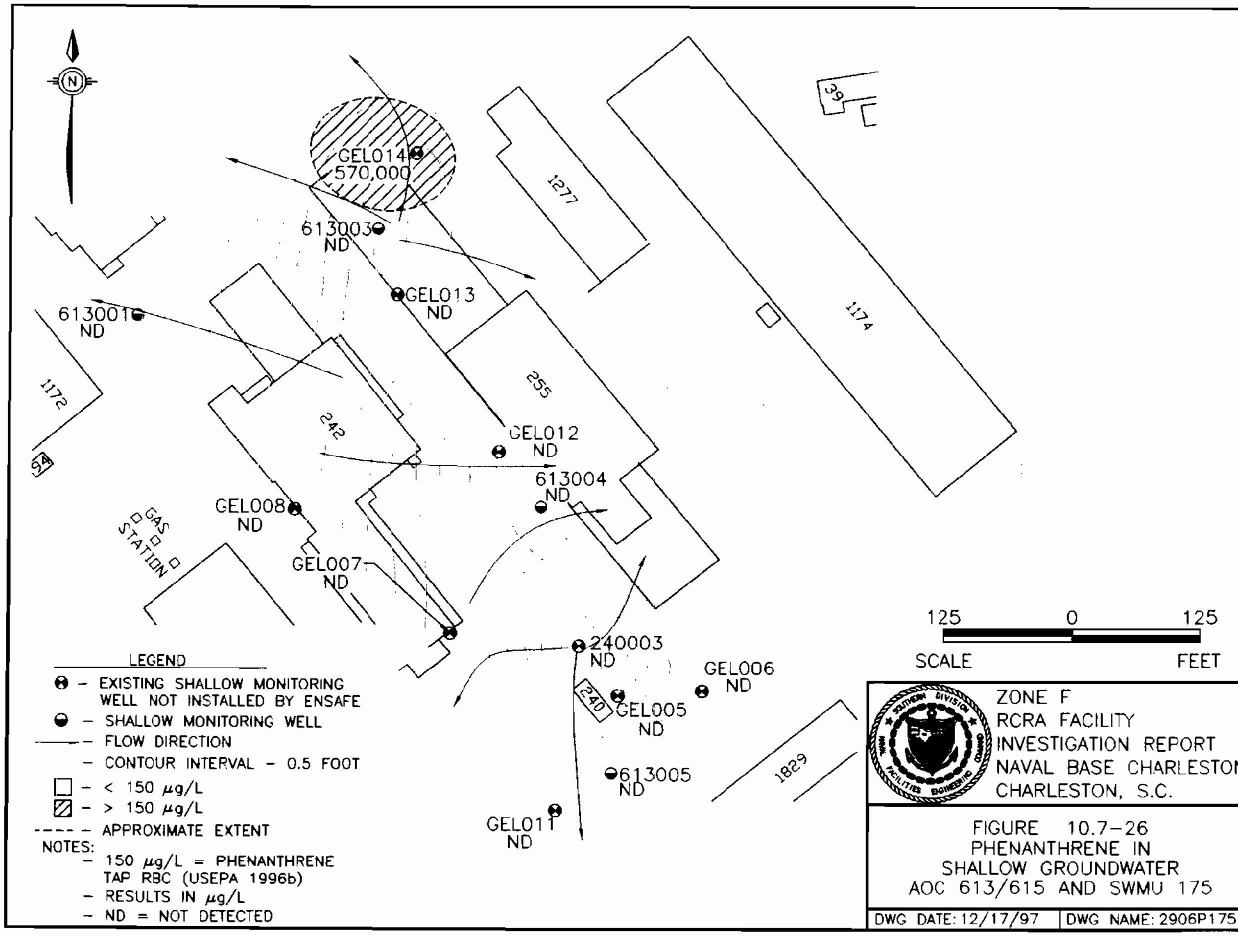


FIGURE 10.7–25
FLUORENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175



LEGEND
- EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- SHALLOW MONITORING WELL
- FLOW DIRECTION
- CONTOUR INTERVAL - 0.5 FOOT
- < 150 μg/L
- > 150 μg/L
- APPROXIMATE EXTENT

NOTES:
- 150 μg/L = PHENANTHRENE TAP RBC (USEPA 1996b)
- RESULTS IN μg/L
- ND = NOT DETECTED

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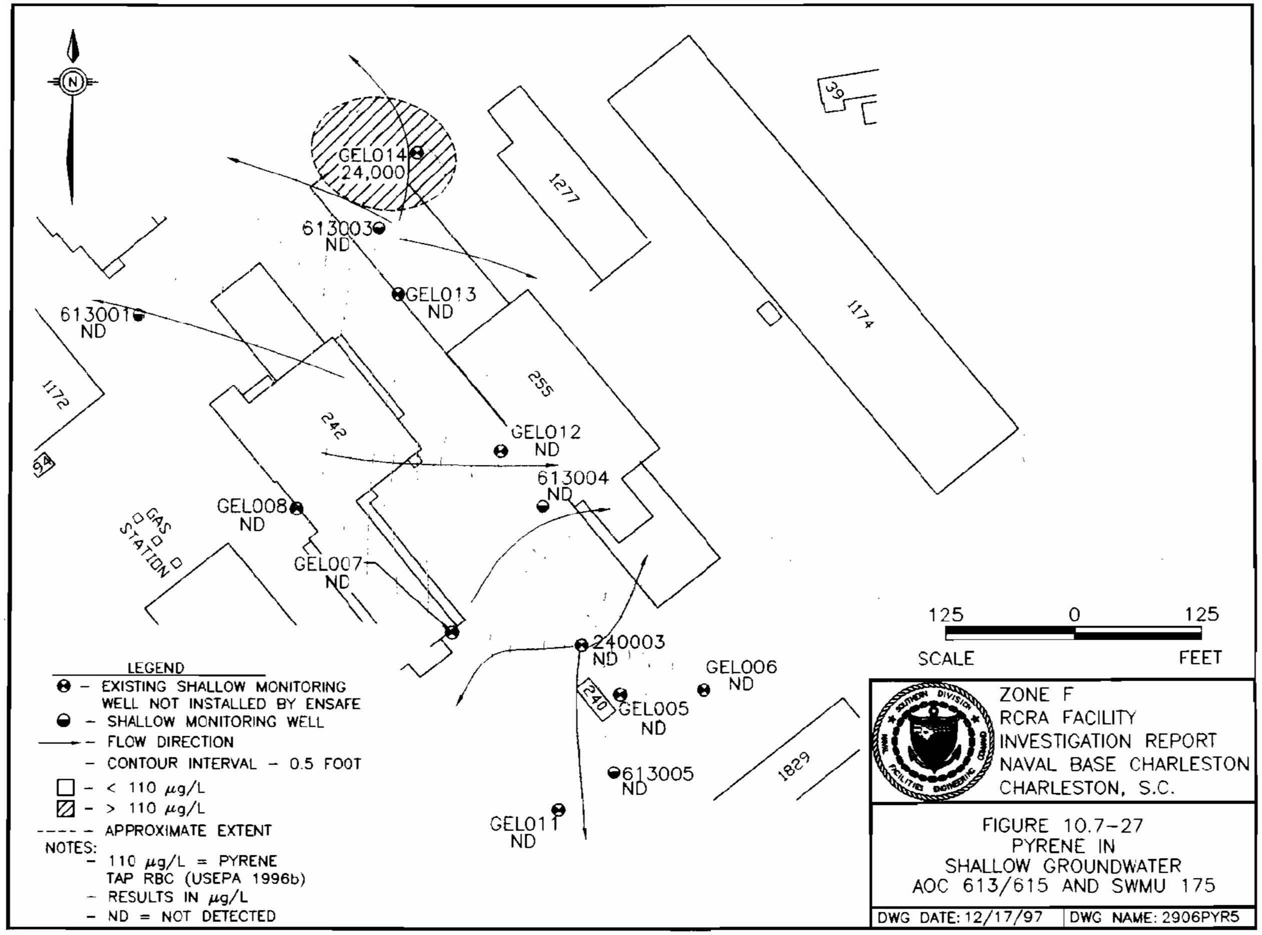
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7-26
PHENANTHRENE IN SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175

DWG DATE: 12/17/97 | DWG NAME: 2906P175



ZONE F
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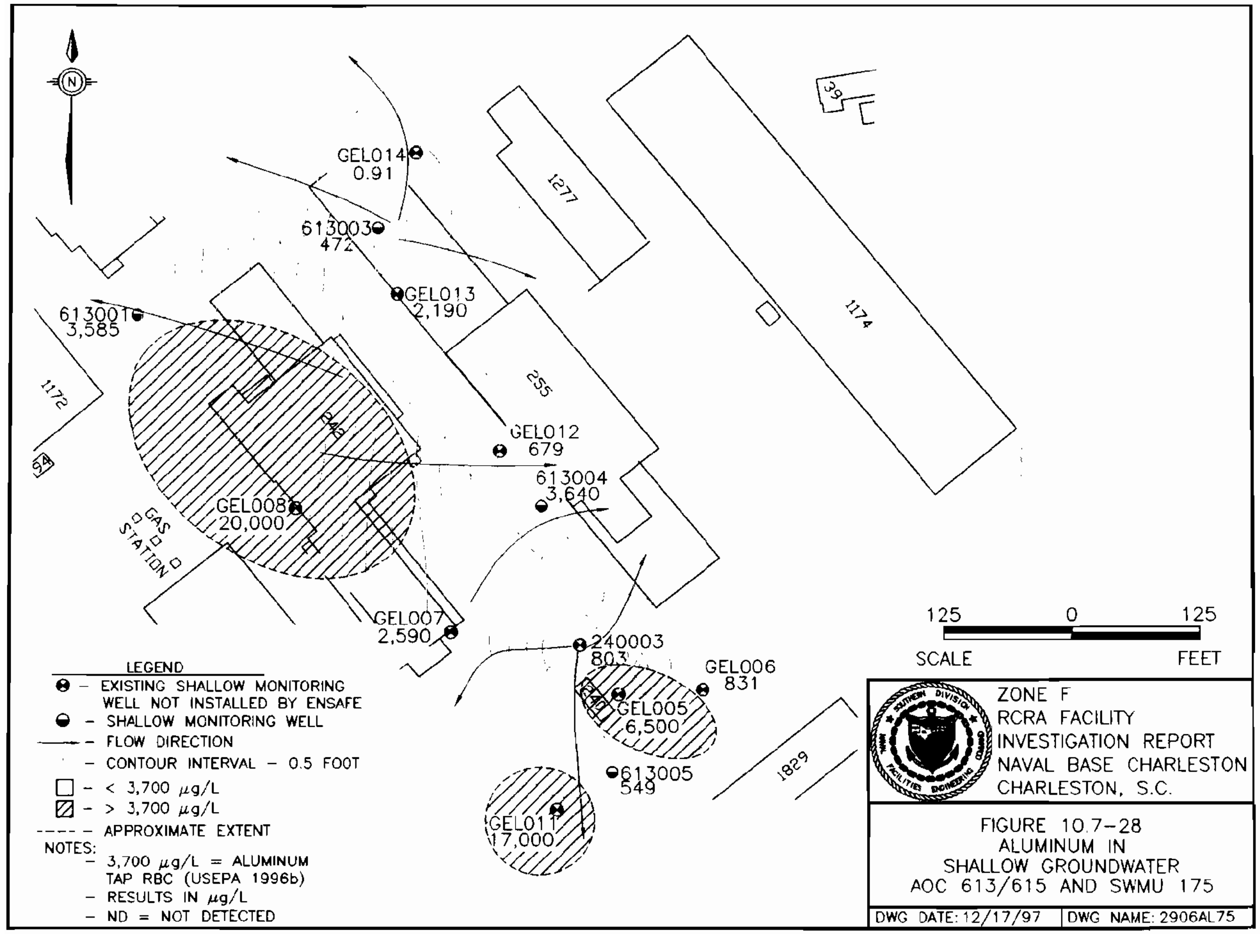
FIGURE 10.7-27
PYRENE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175

DWG DATE: 12/17/97 | DWG NAME: 2906PYR5



GEL014
0.91
613003
472
GEL013
2,190
613001
3,585
1277
1174
255
1172
GEL012
679
613004
3,640
GEL008
20,000
GAS STATION
GEL007
2,590
240003
803
GEL006
831
GEL005
6,500
613005
549
GEL011
17,000
1829
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 3,700 μg/L
– > 3,700 μg/L
– APPROXIMATE EXTENT
NOTES:
– 3,700 μg/L = ALUMINUM TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7–28
ALUMINUM IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906AL75

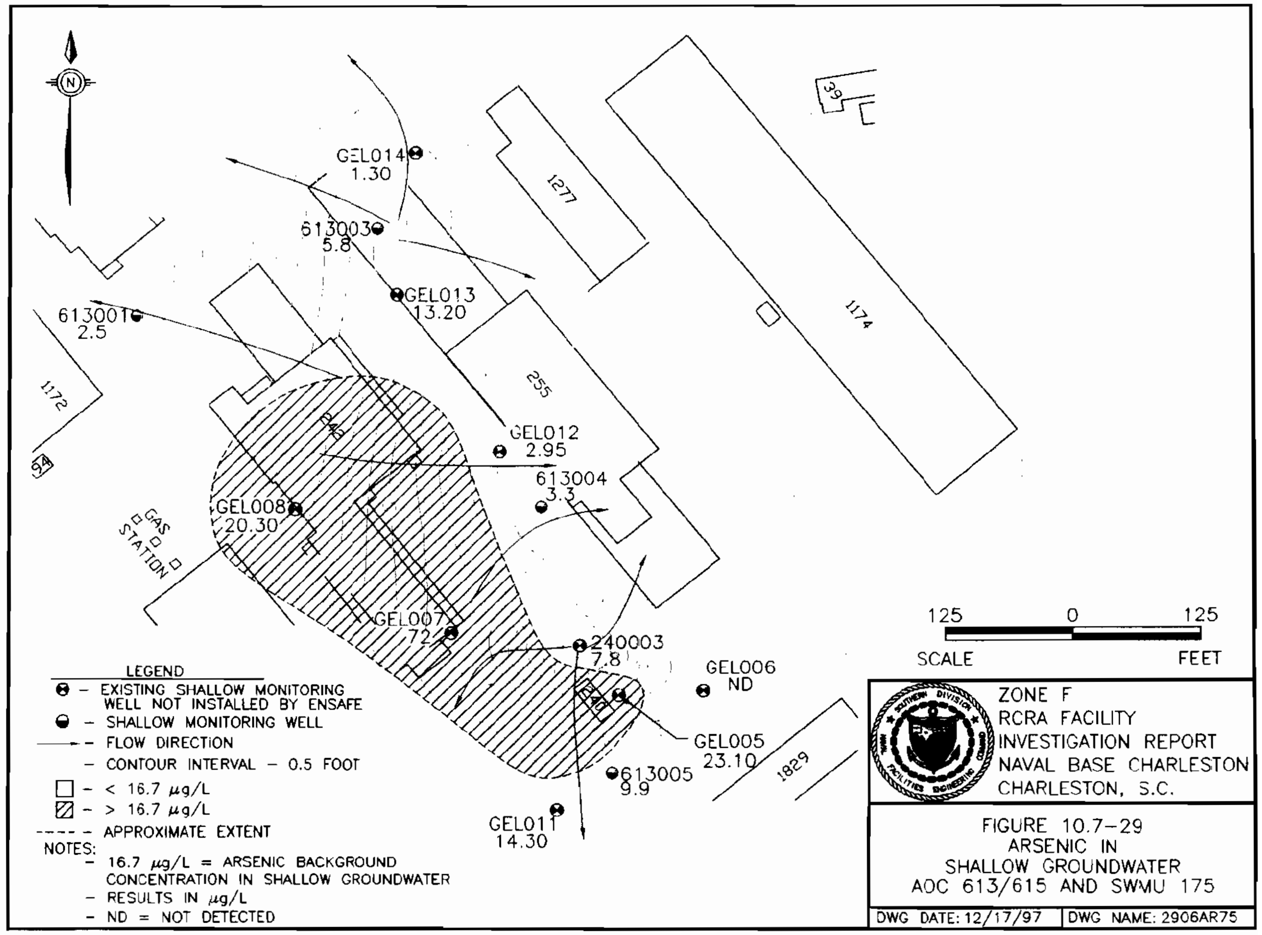
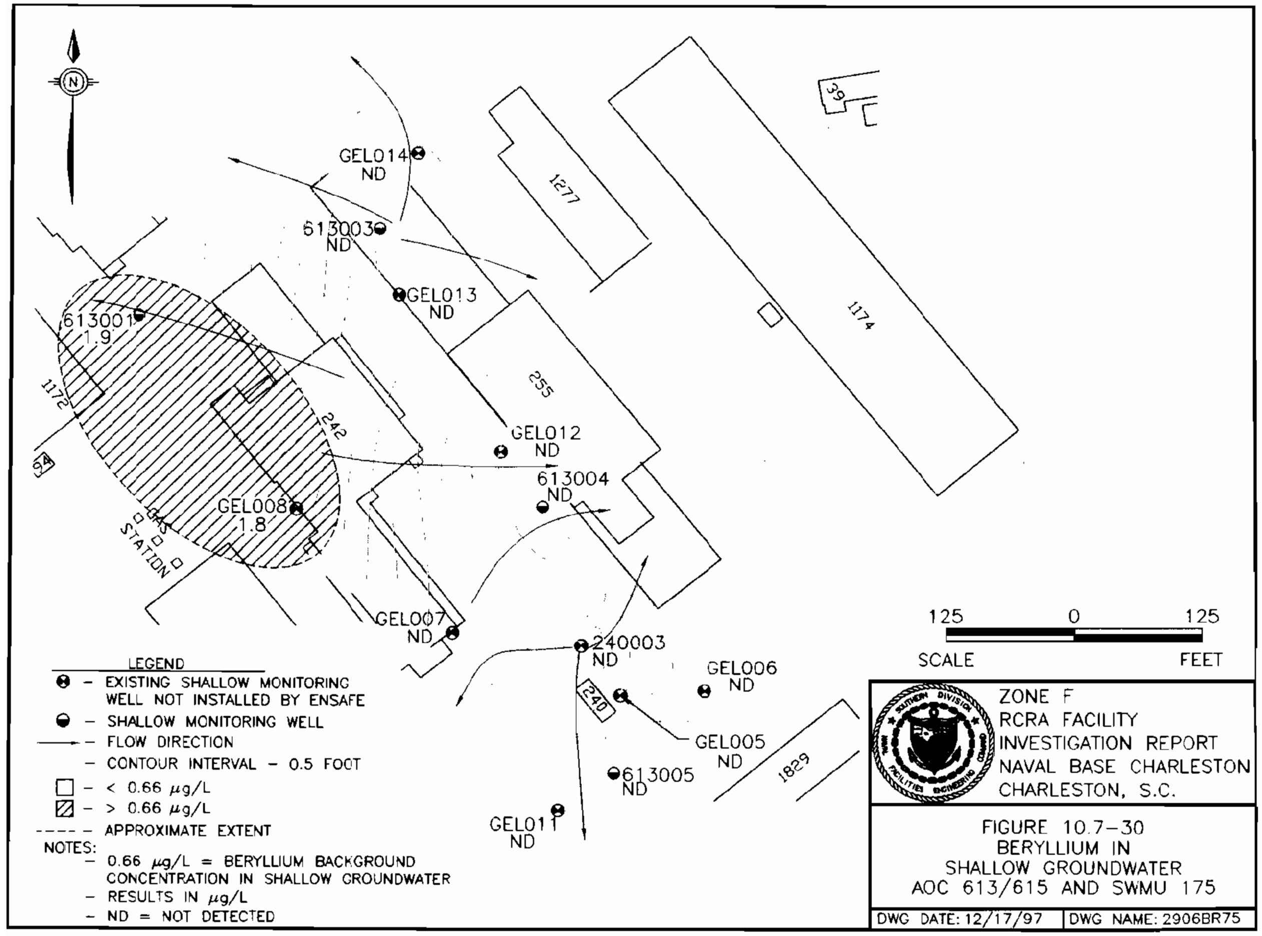


FIGURE 10.7–29
ARSENIC IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175



GEL014
ND
613003
ND
GEL013
ND
613001
1.9
1277
1174
255
242
1172
54
GEL012
ND
613004
ND
GEL008
1.8
GAS STATION
GEL007
ND
240003
ND
GEL006
ND
240
GEL005
ND
613005
ND
GEL011
ND
1829
39
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 0.66 μg/L
– > 0.66 μg/L
---- – APPROXIMATE EXTENT
NOTES:
– 0.66 μg/L = BERYLLIUM BACKGROUND CONCENTRATION IN SHALLOW GROUNDWATER
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7–30
BERYLLIUM IN SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906BR75

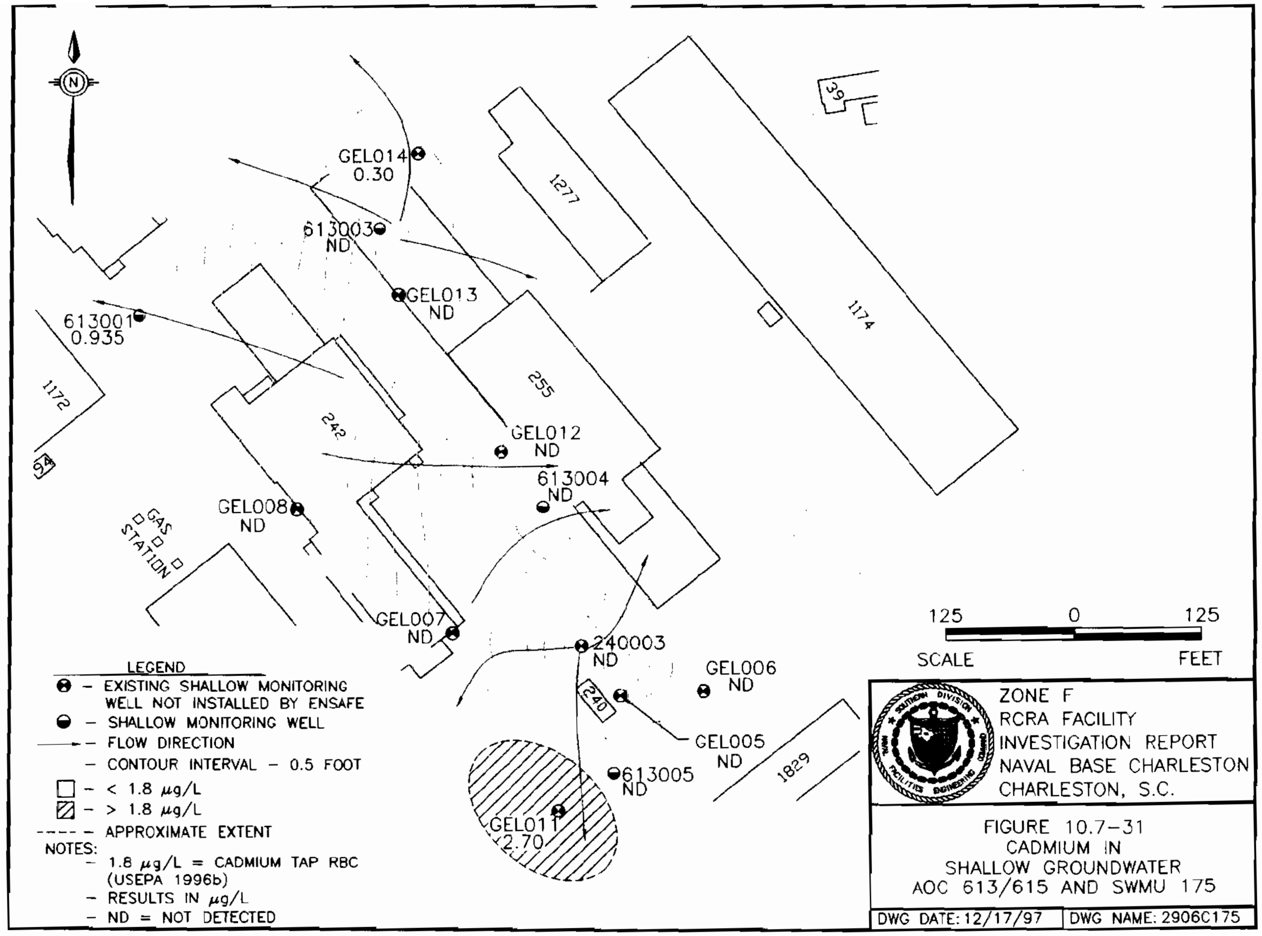
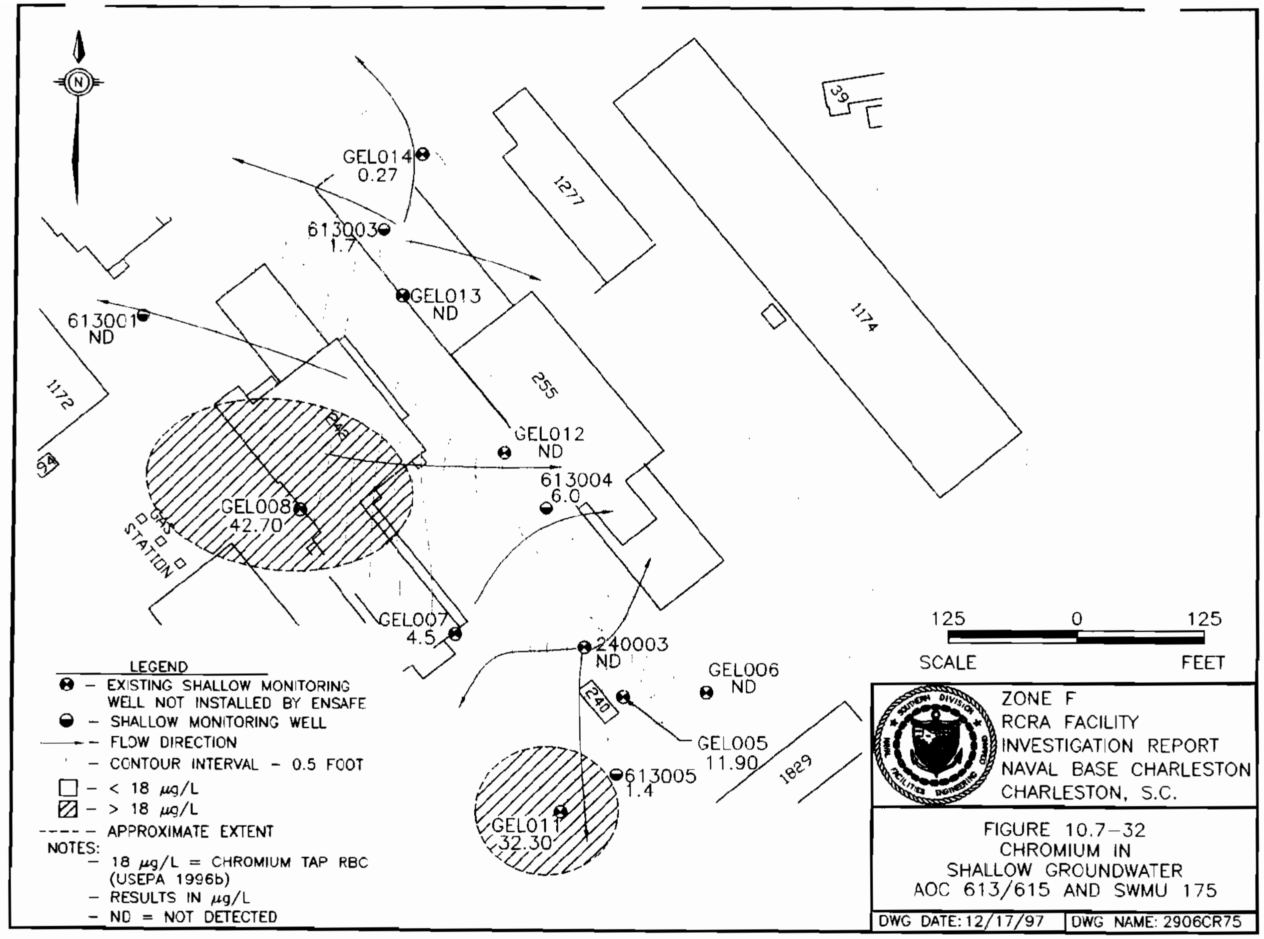


FIGURE 10.7–31
CADMIUM IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175



GEL014
0.27
613003
1.7
GEL013
ND
613001
ND
1277
1174
39
1172
54
255
GEL012
ND
613004
6.0
GEL008
42.70
GAS STATION
GEL007
4.5
240003
ND
GEL006
ND
240
GEL005
11.90
613005
1.4
1829
GEL011
32.30
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 18 μg/L
– > 18 μg/L
– APPROXIMATE EXTENT
NOTES:
– 18 μg/L = CHROMIUM TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
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INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7–32
CHROMIUM IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906CR75

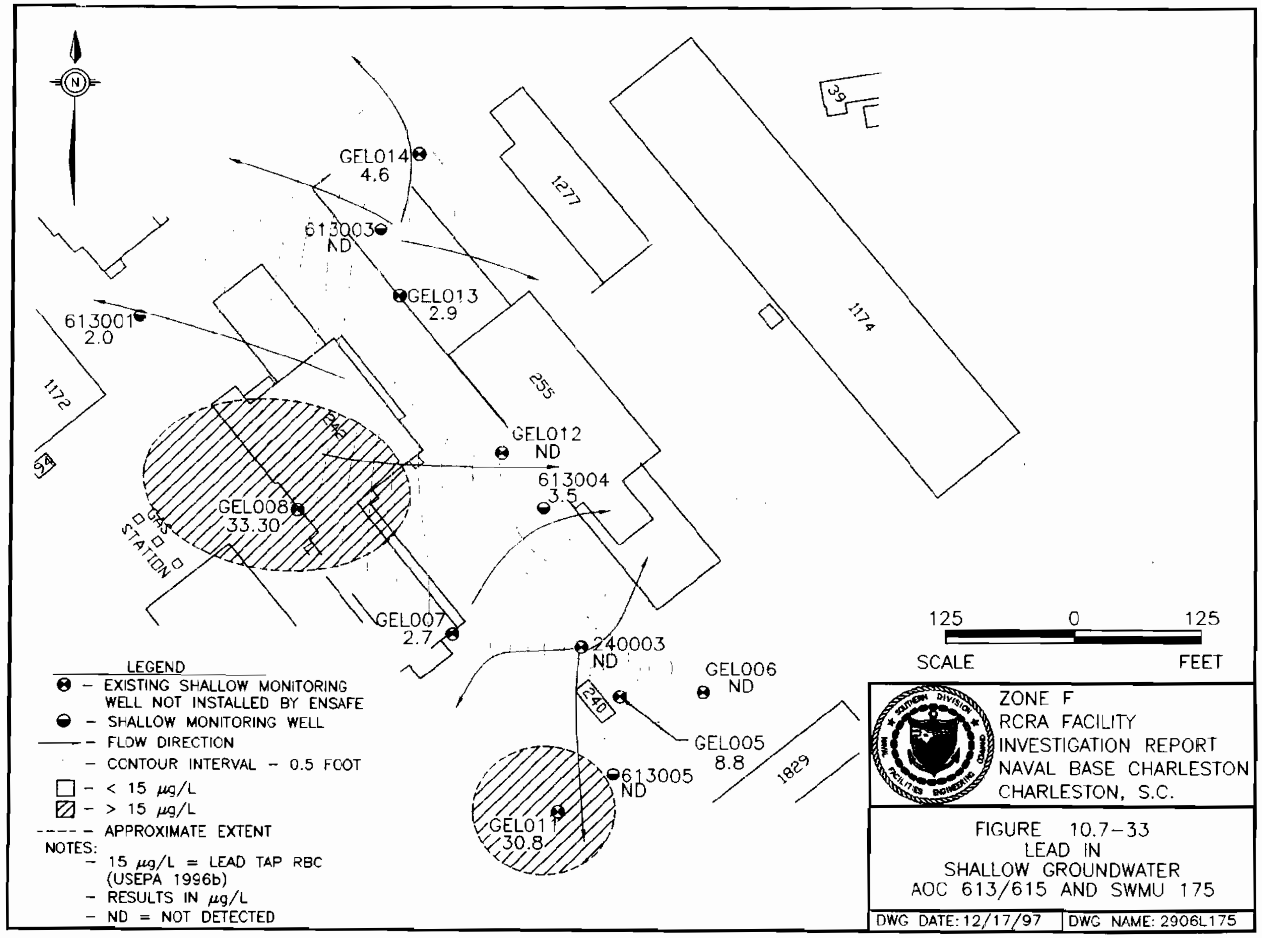
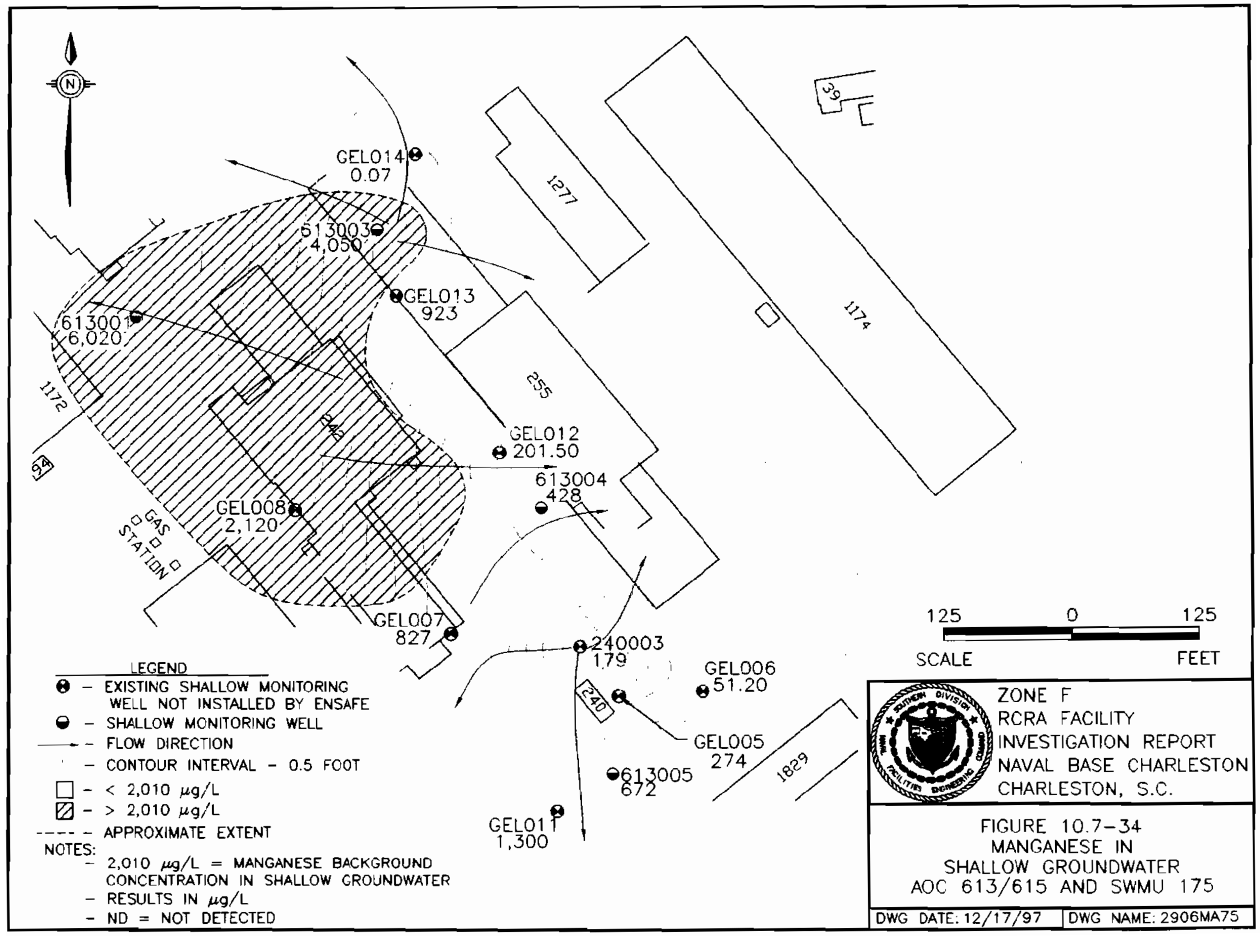
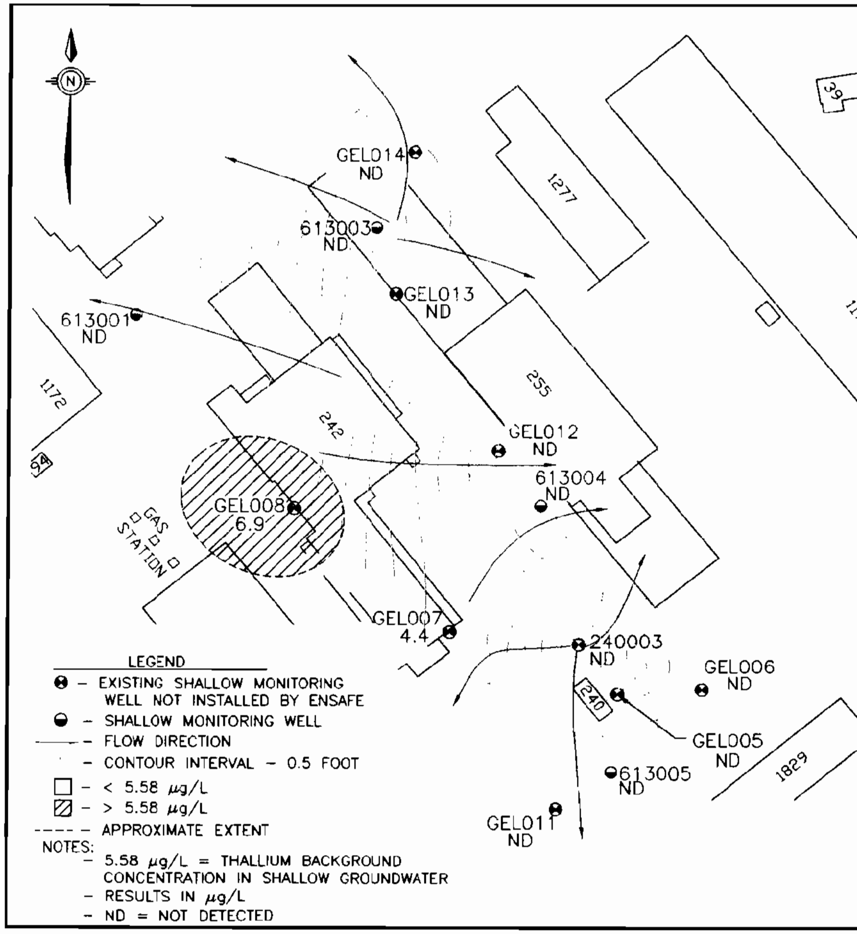


FIGURE 10.7–33
LEAD IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175


N
GEL014
0.07
613003
4,050
GEL013
923
613001
6,020
GEL012
201.50
613004
428
GEL008
2,120
GEL007
827
240003
179
GEL006
51.20
GEL005
274
613005
672
GEL011
1,300
1277
1174
255
1172
94
GAS STATION
240
1829
39
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 2,010 μg/L
– > 2,010 μg/L
– APPROXIMATE EXTENT
NOTES:
– 2,010 μg/L = MANGANESE BACKGROUND CONCENTRATION IN SHALLOW GROUNDWATER
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7–34
MANGANESE IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906MA75



ZONE F
RCRA FACILITY
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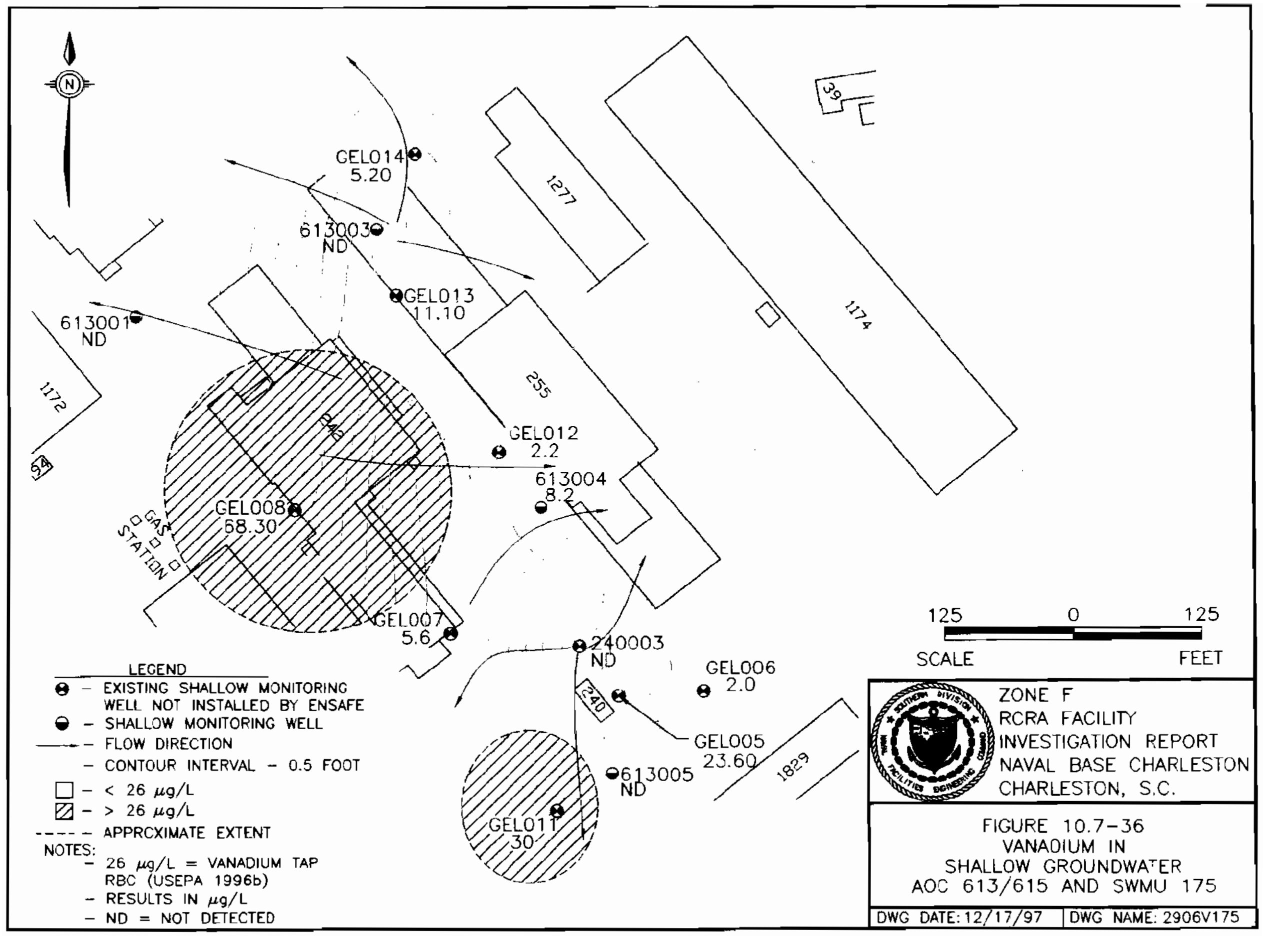
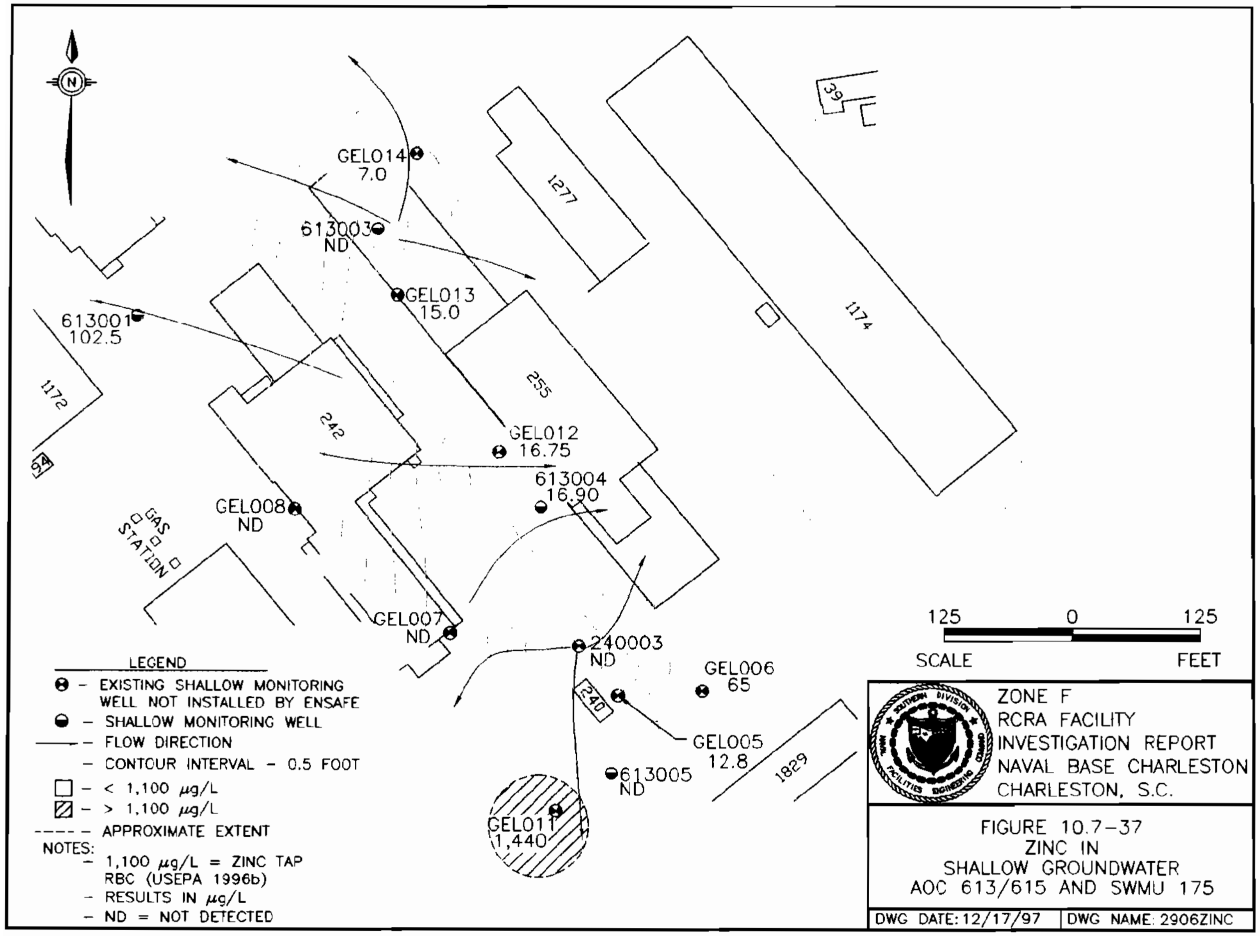
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7-35
THALLIUM IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175

DWG DATE: 12/17/97 | DWG NAME: 2906TL75


N
GEL014
5.20
613003
ND
GEL013
11.10
613001
ND
1277
1174
39
255
1172
54
GEL012
2.2
613004
8.2
GEL008
58.30
GAS STATION
GEL007
5.6
240003
ND
GEL006
2.0
240
GEL005
23.60
613005
ND
1829
GEL011
30
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 26 μg/L
– > 26 μg/L
– APPROXIMATE EXTENT
NOTES:
– 26 μg/L = VANADIUM TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-36
VANADIUM IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906V175



N
GEL014
7.0
613003
ND
GEL013
15.0
613001
102.5
GEL012
16.75
613004
16.90
GEL008
ND
GAS STATION
GEL007
ND
240003
ND
GEL006
65
GEL005
12.8
613005
ND
GEL011
1,440
1277
1174
39
255
242
1172
240
1829
125 0 125
SCALE FEET
LEGEND
– EXISTING SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
– SHALLOW MONITORING WELL
– FLOW DIRECTION
– CONTOUR INTERVAL – 0.5 FOOT
– < 1,100 μg/L
– > 1,100 μg/L
– APPROXIMATE EXTENT
NOTES:
– 1,100 μg/L = ZINC TAP RBC (USEPA 1996b)
– RESULTS IN μg/L
– ND = NOT DETECTED
ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-37
ZINC IN
SHALLOW GROUNDWATER
AOC 613/615 AND SWMU 175
DWG DATE: 12/17/97
DWG NAME: 2906ZINC

10.7.6 Fate and Transport Assessment

Environmental media sampled as part of this investigation include surface soil, subsurface soil, shallow and deep groundwater, and storm sewer sediment. Potential constituent migration pathways investigated for AOCs 613/615 and SWMU 175 include soil-to-groundwater, groundwater-to-surface water, surface soil-to-sediment, and emission of volatiles from surface soil to air.

10.7.6.1 Soil-to-Groundwater Cross-Media Transport

Table 10.7.12 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

Three organics - 1,1,2,2 tetrachloroethane, methylene chloride, and benzo(a)anthracene - were detected in surface soil exceeding their respective SSLs. Benzo(a)anthracene was the only organic exceedance repeated in subsurface soil. Notably, none of these constituents were present in shallow groundwater. The vertical distribution of detected organics provides that VOCs were detected at higher concentrations in surface soil, while SVOCs were observed at significantly higher concentrations in subsurface soil. These distributions may reflect a secondary enrichment of VOCs via volatilization without an exit path (pavement covers the area), while the SVOC distribution may reflect selective degradation (possibly biological) favorable to shallow horizons, or alternatively, a subsurface source such as a UST. Three inorganics - arsenic, chromium, and thallium - were present in surface soil at concentrations exceeding their SSLs. No inorganics were detected exceeding their SSLs in subsurface soil. These three inorganics were also present at elevated levels (exceedances) in shallow groundwater. The general vertical distribution of

Table 10.7.12
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 613, AOC 615, and SWMU 175
Charleston, South Carolina

Parameter	Max. Concentration # Surface Soil	Subsurface Soil	Max. Concentration Shallow GW	Deep GW	Screening Concentration * Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	170	ND	ND	ND	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
Benzene	11	ND	3800	ND	30	0.36	109	UG/KG	UG/L	NO	YES	YES
2-Butanone (MEK)	55	ND	ND	ND	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	110	14	1	3	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chloromethane	ND	ND	2	ND	6.6	1.4	NA	UG/KG	UG/L	NO	YES	NO
1,1,2,2-Tetrachloroethane	32	ND	ND	ND	3	0.052	90.2	UG/KG	UG/L	YES	NO	NO
1,1-Dichloroethane	2	ND	2	ND	23000	810	NA	UG/KG	UG/L	NO	NO	NO
1,1-Dichloroethene	3	ND	ND	ND	60	0.044	2240	UG/KG	UG/L	NO	NO	NO
1,2-Dichloroethene (total)	14	ND	24	ND	400	55	NA	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	30	32	ND	ND	13000	1300	4.3	UG/KG	UG/L	NO	NO	NO
2-Hexanone	18	ND	ND	ND	27600	2900	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	50	ND	ND	ND	20	4.1	2560	UG/KG	UG/L	YES	NO	NO
Tetrachloroethene	ND	ND	2	ND	60	1.1	45	UG/KG	UG/L	NO	YES	NO
Toluene	26	ND	4900	24	12000	750	37	UG/KG	UG/L	NO	YES	YES
Trichloroethene	23	ND	3	ND	60	1.6	NA	UG/KG	UG/L	NO	YES	NO
Vinyl chloride	2	ND	ND	ND	10	0.019	NA	UG/KG	UG/L	NO	NO	NO
Xylene (total)	120	46	4	ND	142000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	590	55000	210000	ND	570000	2200	9.7	UG/KG	UG/L	NO	YES	YES
Acenaphthylene	120	ND	ND	ND	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	3800	26000	1	ND	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	100	ND	3	1	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	250	360	ND	ND	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	2400	5300	ND	ND	2000	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	1200	1200	ND	ND	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	1800	2700	ND	ND	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	1500	ND	ND	ND	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	3000	3300	ND	ND	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	130	270	ND	ND	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	280	450	ND	ND	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	170	ND	ND	ND	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	470	46000	ND	ND	240000	150	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	74	ND	ND	ND	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	380	ND	40000	ND	3600000	4.8	NA	UG/KG	UG/L	NO	YES	NO
Fluoranthene	4500	32000	ND	ND	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	1100	60000	340000	ND	560000	1500	NA	UG/KG	UG/L	NO	YES	NO
2-Methylnaphthalene	6800	43000	2400000	ND	126000	1500	NA	UG/KG	UG/L	NO	YES	NO
4-Methylphenol (p-cresol)	81	ND	ND	ND	1380	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	81	38000	3	ND	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	3100	110000	570000	ND	1380000	1500	NA	UG/KG	UG/L	NO	YES	NO
Pyrene	8500	18000	24000	ND	4200000	1100	NA	UG/KG	UG/L	NO	YES	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.0361	NA	0.306	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
TPH - Gasoline Range Organics												
Gasoline	NA	NA	1950000	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	26700	10000	20000	465	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	1.1	ND	0.15	ND	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	44.8	13	72	4.7	29	16.7	36	MG/KG	UG/L	YES	YES	YES
Barium	48	18.6	111	232	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1.7	0.78	1.9	0.77	63	0.66	NA	MG/KG	UG/L	NO	YES	NO
Cadmium	1.5	0.21	2.7	ND	8	18	9.3	MG/KG	UG/L	NO	NO	NO

Table 10.7.12
Chemicals Detected in Surface Soil, Subsurface Soil, Shallow Groundwater, and Deep Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 613, AOC 615, and SWMU 175
Charleston, South Carolina

Parameter	Max. Concentration # Surface Soil	Subsurface Soil	Max. Concentration Shallow GW	Deep GW	Screening Concentration * Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Chromium (total)	48.1	29.5	42.7	3.4	38	180	50	MG/KG	UG/L	YES	NO	NO
Cobalt	8.3	4.1	104	ND	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	143	15.6	19.8	ND	920	1500	2.9	MG/KG	UG/L	NO	NO	YES
Cyanide	ND	NA	2	NA	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	103	31.9	33.3	ND	400	15	8.5	MG/KG	UG/L	NO	YES	YES
Manganese	776	309	6020	267	1100	2010	NA	MG/KG	UG/L	NO	YES	NO
Mercury	0.98	0.23	0.24	ND	2	11	0.025	MG/KG	UG/L	NO	NO	YES
Nickel	15.9	9.7	58.9	3.2	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	2.6	0.95	5.9	ND	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	0.27	ND	ND	ND	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Thallium	1.5	ND	6.9	ND	1.24	2.9	21.3	MG/KG	UG/L	YES	YES	NO
Vanadium	80.6	36	68.3	4.2	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	159	66.1	1440	ND	12000	11000	86	MG/KG	UG/L	NO	NO	YES

Maximum concentrations for soil represent DPT sample results.

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, adapted from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background reference value

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

detected inorganics shows a significant reduction in concentrations with depth. This distribution is consistent with a surface source and the general tendency for attenuation with depth as a result of adsorption. In general, all of the detected soil contaminants are consistent with past site activities. Importantly, there are a number of parameters, primarily SVOCs, and inorganics which were detected at concentrations exceeding respective screening levels in groundwater which were also present in site soil, this suggests that the use of generic SSLs at this site may underestimate the viability of the soil-to-groundwater pathway. At any rate, the presence of coupled-media (linked presences) contaminants indicates the soil-to-groundwater pathway may have merit at this site, but is not accurately predicted through the use of generic soil SSLs.

10.7.6.2 AOCs 613/615 and SWMU 175 Groundwater-to-Surface Water Cross-Media Transport

Table 10.7.12 also compares maximum detected organic constituent concentrations in shallow and deep groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background concentrations for groundwater, as well as to the saltwater/surface water chronic values. To provide a conservative screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Eleven organic species - benzene, chloromethane, PCE, toluene, TCE, acenapthene, bis(2-ethylhexyl)phthalate, fluorene, 2-methylnapthalene, phenanthrene, and pyrene - were detected in shallow groundwater at concentrations above screening criteria. None of these exceedances were repeated in deep groundwater; in fact, toluene, benzoic acid, and carbon disulfide were the only organic parameters detected in the deep groundwater. Benzene and toluene were significantly above the RBCs and saltwater screening criteria; the remaining VOCs were only slightly above the RBC. All of the SVOCs greatly exceeded the RBCs, while only acenapthene exceeded the saltwater criteria. Notably, benzene, chloromethane, PCE, toluene, and TCE, and the SVOC bis(2-ethylhexyl)phthalate were not detected in subsurface soil, suggesting their provenance may be resident in a smear zone or in an undetected upgradient location. The organic compounds detected are consistent with past site activities; and in particular petroleum related activities. Solvent constituents were present only at very low concentrations. The presence of toluene in deep groundwater suggests that the potential for contaminant migration to the deep zone is probable. Seven inorganics - arsenic, beryllium, lead, manganese, mercury, thallium, and zinc - exceeded the RBCs. Only arsenic, lead, mercury, zinc, and copper exceeded saltwater screening criteria. With the exception of thallium, all of these were detected in subsurface soil; however, only arsenic was present above its SSL. In groundwater, there are significant depletions in concentrations of detections as a function of depth, which is consistent with an overlying, or matrix- resident provenance. The presence of these constituents is also consistent with past site activities; exotic mixes of inorganics are charcteristic of waste oil. The presence of these inorganics above screening levels in groundwater, but less than SSLs in soil, suggests that generic SSLs do not approximate the true leaching potential. The absence of thallium in subsurface soil implies that the source of thallium is aquifer matrix, an undetected upgradient source, or reflective of ambient conditions.

Overall, there are a significant number of constituents at elevated concentrations in groundwater to indicate that the groundwater migration pathway has merit. However, there are no current or planned future users of site groundwater, so a risk-based pathway to human receptors is invalid. As for surface water migration, the Cooper River lies approximately 600 feet to the northeast; there is a minor component of northeastward flow locally in the shallow zone, centered near AOC 615. The distance to discharge, based on aquifer parameters for this site, require approximately 68 years for advective transport alone. However, advective transport is a concept not entirely based in reality. For example, it does not account for attenuation through natural and mechanical processes (biological, natural half-life, and three-dimensional dispersion). Primary constituents (those posing a potential risk) would undoubtedly be affected by these processes. Additionally, dilutional effects at the discharge point would further reduce exposure concentrations to ecological receptors. As a result, the groundwater pathway is not considered to be significant at this site.

10.7.6.3 Soil-to-Sediment Cross Media Transport

Two sediment samples were collected from stormwater catch basins that drain the general site area. Table 10.7.7 summarized the analytes detected in sediment samples. The onc VOC, trichloroethene, detected in the sediment was also detected in site soils at similar concentrations. Nineteen SVOCs were detected in the site sediment samples. These were also detected at concentrations comparable to those of the soil samples. Three pesticides were also detected in the sediment sample 613M001. Pesticides were not detected in site soil. The absence of the pesticides in site soil and the other sediment sample suggest a source other than the site. Possibly from past application near the buildings adjacent to 619M001. For the inorganics, nearly all the analytes detected in soil samples were present were also detected in sediment. Cyanide, detected in 619M001, was not detected in site soil samples of the 23 species present in soil, 17 were also detected in the sediment samples at the same order of magnitude. This relationship links surface soil and sediment, and implies either that surface soil is the primary source of these constituents in sediment, or at least contributes to the sediment load present in the stormwater drainage system. The exception to this link are the pesticides and cyanide.

10.7.6.4 Soil-to-Air Cross-Media Transport

Table 10.7.13 compares the VOCs detected in surface soil samples collected at this site with corresponding soil-to-air volatilization screening levels. Little or no surface soil is exposed at AOC 613/615 and SWMU 175. In addition, none of the VOCs was reported at a maximum concentration exceeding its corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not valid at the site.

Table 10.7.13
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone F: AOC 613, AOC 615, and SWMU 175
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	170	100000000	UG/KG	NO
Benzene	11	800	UG/KG	NO
2-Butanone (MEK)	55	10000	UG/KG	NO
Carbon disulfide	110	720000	UG/KG	NO
1,1,2,2-Tetrachloroethane	32	600	UG/KG	NO
1,1-Dichloroethane	2	1300000	UG/KG	NO
1,1-Dichloroethene	3	70	UG/KG	NO
1,2-Dichloroethene (total)	14	1200000	UG/KG	NO
Ethylbenzene	30	400000	UG/KG	NO
2-Hexanone	18	10000	UG/KG	NO
Methylene chloride	50	13000	UG/KG	NO
Toluene	26	650000	UG/KG	NO
Trichloroethene	23	5000	UG/KG	NO
Vinyl chloride	2	30	UG/KG	NO
Xylene (total)	120	410000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996. Values for 2-Butanone and 2-Hexanone were estimated.

NA - Not available

10.7.6.5 Fate and Transport Summary

Only three organics and three inorganics were present in site soil at concentrations exceeding SSLs. Only one - arsenic - was also present in groundwater at concentrations exceeding screening levels. However, a number of constituents exceeding screening levels were present in groundwater but did not exceed soil screening levels; this clearly suggests that generic SSLs may not present true leaching potential at this site. In soil, both VOCs and inorganics exhibited significant attenuation with depth, while SVOCs exhibited significant enrichment. The nature of contaminants are consistent with past site activities; the vertical distributions are complex but suggest that biodegradation of organics, adsorption of inorganics, and secondary enrichment of SVOCs may be occurring.

Numerous organics and inorganics were present in groundwater above screening criteria. Without exception, attenuation with depth was a common feature. Most constituents were also present in site soils, indicating that leachability from overlying soil or aquifer matrix is probable, and not adequately quantified using generic SSLs. However, the risk-based exposure pathway is invalid due to non-use of the resource. The surface water migration pathway has some merit; however, consideration of attenuation mechanisms as well as dilutional effects at discharge points provide that this pathway is expected to be insignificant at this site.

10.7.7 Human Health Risk Assessment

10.7.7.1 Site Background and Investigative Approach

SWMU 175 is the former crane painting area near Building 1277. AOC 613 is the former locomotive repair shop at the former Building 1169. AOC 615 is the old chain locker at the former Building 1391. The investigation of these sites was combined due to their close proximity and anticipated similar COPCs. Nearly all of the site area is covered by buildings and pavement. Materials released, stored, or disposed of at the site include blast media, paint constituents, heavy metals, lead acetone, xylene, toluene, gasoline, oils, grease, cleaning solvents, epoxys, and resins. The following text refers to these sites as combined AOC 613.

During the CSI, 65 DPT soil samples from the upper soil interval and one subsurface sample were collected to identify potential impacts resulting from the activities listed above. Surface soil samples from all 65 boring locations were used to quantitatively assess soil exposure pathways. Subsurface soil is addressed in the previous section, Fate and Transport Assessment for combined AOC 613. Eight existing shallow monitoring wells and six monitoring wells (five shallow; one deep) installed during the Zone F RFI were sampled, and data from the first quarter sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.7.3 and 10.7.5 provide summaries of the sampling effort for combined AOC 613 soil and groundwater.

10.7.7.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.7.14, BEQs, aluminum, arsenic, beryllium, chromium, manganese, thallium, and vanadium were identified as COPCs in surface soil.

Groundwater

As shown in Table 10.7.15, acenaphthene, aluminum, arsenic, benzene, beryllium, cadmium, chloromethane, chromium, 1,2-dichloroethene (total), bis(2-ethylhexyl)phthalate, fluorene, lead, manganese, 2-methylnaphthalene, phenanthrene, pyrene, PCE, thallium, toluene, trichloroethene, vanadium, and zinc were identified as a COPCs for groundwater at combined AOC 613.

Table 10.7.14
Chemicals Present in Site Samples
SWMU 175; and AOCs 613 and 615 - Surface Soil
NAVBASE - Charleston - Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Background	Units	Number Exceeding	
Carcinogenic PAHs													
B(a)P Equiv.	*	25	65	5.98	1775.3	230	34.665	1548.37	88	NA	ug/kg	15	
Benzo(a)anthracene	*	17	65	43	2400	314	15	670	880	NA	ug/kg	1	
Benzo(a)pyrene	*	22	65	47	1200	191	15	670	88	NA	ug/kg	11	
Benzo(b)fluoranthene	*	16	85	46	1800	301	15	670	880	NA	ug/kg	2	
Benzo(k)fluoranthene		16	65	45	1500	236	15	670	8800	NA	ug/kg		
Chrysene		19	65	45	3000	436	15	670	88000	NA	ug/kg		
Dibenz(a,h)anthracene	*	4	65	46	130	88	15	670	88	NA	ug/kg	2	
Indeno(1,2,3-cd)pyrene		9	65	55	280	147	15	670	880	NA	ug/kg		
TCDD Equivalents													
Dioxin Equiv.		1	1	0.0361	0.0361	0.0361	NA	NA	1000	NA	ng/kg		
1234678-HpCDD		1	1	1.09	1.09	1.09	NA	NA	NA	NA	ng/kg		
OCDD		1	1	25.2	25.2	25.2	NA	NA	NA	NA	ng/kg		
Inorganics													
Aluminum (Al)	*	65	65	2570	26700	12358	NA	NA	7800	18500	mg/kg	53	11
Antimony (Sb)		3	65	0.53	1.1	0.72	0.27	0.61	3.1	0.79	mg/kg		
Arsenic (As)	*	65	65	0.71	44.8	10.00	NA	NA	0.43	19.9	mg/kg	65	8
Barium (Ba)		65	65	7.3	48	22.37	NA	NA	550	61.5	mg/kg		
Beryllium (Be)	*	60	65	0.11	1.7	0.67	0.13	0.32	0.15	1.05	mg/kg	53	12
Cadmium (Cd)		39	65	0.04	1.5	0.28	0.04	0.23	3.9	0.26	mg/kg		
Calcium (Ca)	N	65	65	441	346000	18193	NA	NA	NA	NA	mg/kg		
Chromium (Cr)	*	65	65	4.5	48.1	22.31	NA	NA	39	34.8	mg/kg	10	12
Cobalt (Co)		65	65	0.35	8.3	3.14	NA	NA	470	15.1	mg/kg		
Copper (Cu)		49	65	0.92	143	18.53	0.58	15.8	310	48.2	mg/kg		
Iron (Fe)	N	65	65	1750	36200	16811	NA	NA	NA	NA	mg/kg		
Lead (Pb)		65	65	1.5	103	26.89	NA	NA	400	180	mg/kg		
Magnesium (Mg)	N	65	65	157	8545	2164	NA	NA	NA	NA	mg/kg		
Manganese (Mn)	*	65	65	7.4	775.5	178	NA	NA	180	307	mg/kg	24	13
Mercury (Hg)		52	65	0.04	0.96	0.20	0.04	0.05	2.3	0.62	mg/kg		
Nickel (Ni)		63	65	1.1	15.9	6.79	1	1.6	160	12.6	mg/kg		
Potassium (K)	N	55	65	239	3005	1230	215	235	NA	NA	mg/kg		
Selenium (Se)		50	65	0.41	2.6	1.07	0.32	0.49	39	1.15	mg/kg		
Silver (Ag)		1	65	0.27	0.27	0.27	0.15	0.67	39	1.85	mg/kg		
Sodium (Na)	N	51	65	166	6950	1219	149	1670	NA	NA	mg/kg		
Thallium (Tl)	*	24	65	0.47	1.5	0.83	0.34	0.69	0.63	NA	mg/kg	16	
Vanadium (V)	*	65	65	3.8	80.6	35.99	NA	NA	55	48.9	mg/kg	12	16
Zinc (Zn)		60	65	5.9	159	56.74	4.1	8.1	2300	198	mg/kg		
Semivolatile Organics													
Acenaphthene		9	65	58	590	229	15	670	470000	NA	ug/kg		
Acenaphthylene		1	65	120	120	120	15	670	310000	NA	ug/kg		
Anthracene		9	65	89	3800	740	15	670	2300000	NA	ug/kg		
Benzo(g,h,i)perylene		13	65	51	250	115	15	670	310000	NA	ug/kg		
Benzoic acid		10	65	51	100	69.30	74	3400	31000000	NA	ug/kg		
Butylbenzylphthalate		1	65	170	170	170	15	670	1600000	NA	ug/kg		
Dibenzofuran		6	65	64	470	209	15	670	31000	NA	ug/kg		
Di-n-butylphthalate		1	65	74	74	74.0	15	670	780000	NA	ug/kg		
bis(2-Ethylhexyl)phthalate		19	65	41	380	121	15	770	46000	NA	ug/kg		
Fluoranthene		23	65	62	4500	455	15	650	310000	NA	ug/kg		
Fluorene		12	65	59	1100	322	15	670	310000	NA	ug/kg		
4-Methylphenol		1	65	81	81	81.0	15	670	39000	NA	ug/kg		
2-Methylnaphthalene		10	65	66	6800	1214	15	650	310000	NA	ug/kg		
Naphthalene		1	64	81	81	81.00	15	670	310000	NA	ug/kg		
Phenanthrene		20	65	44	3100	536	15	670	310000	NA	ug/kg		
Pyrene		30	65	48	8500	541	15	650	230000	NA	ug/kg		

Table 10.7.14
Chemicals Present in Site Samples
SWMU 175; and AOCs 613 and 615 - Surface Soil
NAVBASE - Charleston - Zone F
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Background	Units	Number Exceeding
Volatile Organics											
Acetone	1	65	170	170	170	11	730	780000	NA	ug/kg	
Benzene	5	65	2	11	4.40	5	37	22000	NA	ug/kg	
2-Butanone	22	65	3	55	15.00	6	130	4700000	NA	ug/kg	
Carbon disulfide	12	65	2	110	12.83	5	37	780000	NA	ug/kg	
1,1-Dichloroethane	2	65	1	2	1.50	5	37	780000	NA	ug/kg	
1,1-Dichloroethene	1	65	3	3	3.00	5	37	7000	NA	ug/kg	
1,2-Dichloroethene (total)	2	65	13	14	13.5	5	37	70000	NA	ug/kg	
Ethylbenzene	2	65	1	30	15.5	5	32	780000	NA	ug/kg	
2-Hexanone	1	65	18	18	18.0	11	74	630000	NA	ug/kg	
Methylene chloride	7	65	1	50	16.0	2	74	85000	NA	ug/kg	
1,1,2,2-Tetrachloroethane	1	65	32	32	32.0	5	32	3200	NA	ug/kg	
Toluene	5	65	3	26	12.6	5	37	1600000	NA	ug/kg	
Trichloroethene	9	65	1	23	5.4	5	37	58000	NA	ug/kg	
Vinyl chloride	1	65	2	2	2.0	11	74	340	NA	ug/kg	
Xylene (Total)	4	65	4	120	35.5	5	32	16000000	NA	ug/kg	

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - millgram per kilogram
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram
NA - Not appicable

Table 10.7.15
Chemicals Present in Site Samples
SWMU 175; AOCs 613 and 615 - Shallow and Deep Groundwater
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Renge of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Reference	Units	Number Exceeding RBC	Number Exceeding Ref.
TCDD Eqivelents													
Dioxin Equiv.		1	2	0.306	0.306	0.306	0.0498	0.0498	0.45	NA	PG/L		
OCDD		1	2	306	306	306	49.8	49.8	NA	NA	PG/L		
TPH													
Gasoline		1	1	1950000	1950000	1950000.00	NA	NA	NA	NA	UG/L		
Inorganics													
Aluminum (Al)	*	14	14	0.91	20000	4236.07	NA	NA	3700	224	UG/L	3	13
Antimony (Sb)		1	14	0.15	0.15	0.15	2.1	5.1	1.5	NA	UG/L		
Arsenic (As)	*	13	14	1.3	72	13.93	2.5	2.5	0.045	16.7	UG/L	12	3
Barium (Ba)		14	14	1.2	232	69.68	NA	NA	260	94.3	UG/L		
Beryllium (Be)	*	3	14	0.77	1.9	1.49	0.01	1.6	0.016	0.66	UG/L	2	3
Cadmium (Cd)	*	3	14	0.3	2.7	1.31	0.5	0.5	1.8	0.82	UG/L	2	2
Calcium (Ca)	N	14	14	28.3	335000	141484.16	NA	NA	NA	NA	UG/L		
Chromium (Cr)	*	9	14	0.27	42.7	11.57	0.8	5	18	2.05	UG/L	2	5
Cobalt (Co)		7	14	2	104	28.16	0.01	2.9	220	10.9	UG/L		
Copper (Cu)		4	14	3.3	19.8	11.38	0.6	7.1	150	NA	UG/L		
Cyanide (CN)		1	2	2	2	2.00	2	2	73	3.3	UG/L		
Iron (Fe)	N	14	14	16.6	51450	22280.33	NA	NA	NA	NA	UG/L		
Lead (Pb)	*	8	14	2	33.3	11.08	1.7	1.7	15	NA	UG/L	2	
Magnesium (Mg)	N	14	14	1.8	814000	157955.13	NA	NA	NA	NA	UG/L		
Manganese (Mn)	*	14	14	0.07	6020	1236.63	NA	NA	84	2010	UG/L	11	3
Mercury (Hg)		5	14	0.01	0.24	0.13	0.1	0.14	1.1	NA	UG/L		
Nickel (Ni)		12	14	0.89	58.85	11.27	0.8	5.8	73	5.55	UG/L		
Potassium (K)	N	13	14	2300	177000	55530.00	40	40	NA	NA	UG/L		
Selenium (Se)		6	14	0.8	5.9	3.97	2.8	7.1	18	NA	UG/L		
Sodium (Na)	N	14	14	28.1	6150000	1448787.72	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	2	14	4.4	6.9	5.65	0.07	7.5	0.29	5.58	UG/L	2	1
Vanadium (V)	*	10	14	2	68.3	16.04	0.5	2.7	26	1.58	UG/L	2	10
Zinc (Zn)	*	8	14	7	1440	209.49	5.3	25.2	1100	NA	UG/L	1	
Semivolatile Organics													
Acenaphthene	*	1	14	210000	210000	210000.00	10	10	220	NA	UG/L	1	
Anthracene		1	14	1	1	1.00	1	10	1100	NA	UG/L		
Benzoic acid		4	14	1	3	1.75	1	1	15000	NA	UG/L		
bis(2-Ethylhexyl)phthalate	*	1	14	40000	40000	40000.00	10	10	4.8	NA	UG/L	1	
Fluorene	*	2	14	1	340000	170000.50	1	10	150	NA	UG/L	1	
2-Methylnaphthalene	*	1	14	2400000	2400000	2400000.00	10	10	150	NA	UG/L	1	
Naphthalene		1	14	3	3	3.00	3	10	150	NA	UG/L		
Phenanthrene	*	1	14	570000	570000	570000.00	10	10	150	NA	UG/L	1	
Pyrene	*	1	14	24000	24000	24000.00	10	10	110	NA	UG/L	1	
Volatile Organics													
Benzene	*	1	14	3800	3800	3800.00	5	5	0.36	NA	UG/L	1	
Carbon disulfide		2	14	1	3	2.00	1	1	100	NA	UG/L		
Chloromethane	*	1	14	2	2	2.00	2	10	1.4	NA	UG/L	1	
1,1-Dichloroethane		1	14	2	2	2.00	2	5	81	NA	UG/L		
1,2-Dichloroethene (total)	*	3	14	2	24	9.67	2	5	5.5	NA	UG/L	1	
Tetrachloroethene	*	1	14	2	2	2.00	2	5	1.1	NA	UG/L	1	
Toluene	*	4	14	1	4900	1231.75	1	1	75	NA	UG/L	1	
Trichloroethene	*	1	14	3	3	3.00	3	5	1.6	NA	UG/L	1	
Xylene (Total)		3	14	1	4	2.67	1	5	1200	NA	UG/L		

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - microgram per liter
PG/L - picogram per liter
NA - Not applicable

10.7.7.3 Exposure Assessment

Exposure Setting

The combined site is located in an industrial setting on the former naval base. Building 242 is currently situated roughly in the middle of this site which is surrounded by paved parking areas. A portion of this site is currently being transferred to the City of Charleston for the maintanence of municipal vehicles. Nearly 100 percent of the site area is covered by the building and surrounding pavement.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents, although chances are remote since the site is currently being leased to the City of Charleston. Future worker exposure scenarios were addressed quantitatively in this risk assessment, and as a conservative measure a site resident exposure scenario was also assessed. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. Current exposure to workers is discussed qualitatively in relation to the future workers. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (the paved surfacing would prevent direct contact with soil over almost all of the site). Therefore, future worker assessment is considered to be conservatively representative of current site users.

Exposure Pathways

Exposure pathways for the site workers are dermal contact with contaminated surface soil, incidental ingestion of surface soils, ingestion of groundwater through potable use, and inhalation of VOCs resulting from domestic and process uses of groundwater. The exposure pathways for future residential land use are the same as those for the future site worker. Uniform exposure was assumed for all sample locations. Table 10.7.16 presents the justification for exposure pathways assessed in this HHRA.

Since NAVBASE has readily available municipal water, it is highly unlikely that the aquifer will be used as a source of potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, a residential scenario and an industrial scenario were considered for combined AOC 613. Since there is no clear confining layer separating the shallow and deep aquifers, all groundwater data from the surficial aquifer were combined in evaluating the groundwater pathways.

Table 10.7.16
Exposure Pathways Summary — Combined AOC 613
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Worker)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at combined AOC 613.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at combined AOC 613.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.

Table 10.7.16
Exposure Pathways Summary — Combined AOC 613
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses			
Future Site Residents, Site Workers	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater. Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or nonresidential water at combined AOC 613. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Volatile COPCs were identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for datasets consisting of at least 10 samples. Table 10.7.17 summarizes the statistical analysis performed on surface soil data and shows the 95% UCLs calculated for the soil COPCs. Although the site comprises approximately six acres representing multiple potential exposure unit areas, one UCL was

Table 10.7.17
Summary of Statistical Analysis
Surface Soil COPCs; SWMU 175 and AOCs 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Semivolatile Organics								
Benzo(a)pyrene equivalents	65	5.566	1.188	2.512	0.77	1.8	0.77	95% UCL
Inorganics								
Aluminum (Al)	65	9.305	0.504	1.879	14050	26700	14050	95% UCL
Arsenic (As)	65	1.993	0.839	2.149	13.1	44.8	13.1	95% UCL
Beryllium (Be)	65	-0.789	0.872	2.18	0.84	1.7	0.84	95% UCL
Chromium (Cr)	65	2.954	0.584	1.935	26.2	48.1	26.2	95% UCL
Manganese (Mn)	65	4.495	1.313	2.656	328	776	328	95% UCL
Thallium (Tl)	65	-1.002	0.638	1.976	0.53	1.5	0.53	95% UCL
Vanadium (V)	65	3.392	0.683	2.012	44.6	80.6	44.6	95% UCL

NOTES:

mean Arithmetic mean of the logtransformed data
n Number of samples analyzed
SD Standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA Not applicable
EPC Exposure point concentration
UCL 95 percentile upper confidence level mean
MAX Maximum reported concentration

calculated for each COPC to represent the entire site. This was done because COPCs identified for surface soil were evenly distributed across the site, with no definable "hot spots". As a result, the 95% UCL calculated on the entire surface soil data set was considered to represent the reasonable upper-bound average for any conceivable one-half acre exposure unit area within combined AOC 613.

Table 10.7.18 summarizes the determination of the groundwater EPC. Current EPA guidance favors the use of the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. The most concentrated area of thc plume is defined separately for certain COPC groups since one plume could not be defined for all of the COPCs identified in groundwater. A plume of petroleum-related chemicals was represented using data generated from the first quarter sample collected from monitoring well GEL014. The EPCs for these COPCs (acenaphthene, benzene, bis(2-ethylhexyl)phthalate, fluorene, 2-methylnaphthalene, phenanthrene, pyrene, and toluene) were set equal to the concentration reported for the first quarter sample collected from this monitoring well (considered the "most concentrated area" of the petroleum-related chemicals plume). The highest concentrations of inorganic COPCs (except for beryllium, cadmium, manganese) were reported in the first quarter groundwater samples collected from monitoring wells GEL007, GEL008 and GEL011. The EPCs for these COPCs were calculated as the arithmetic mean of the concentrations reported for the first quarter groundwater samples collected from these wells. The highest concentration of cadmium was reported in the groundwater sample collected from monitoring well GEL011, and as a result, the EPC for cadmium was set equal to the first quarter result from this well. The highest concentration for beryllium was reported for the groundwater samples collected from monitoring wells 613001 and GEL008, and as a result the EPC for beryllium was sct cqual to the arithmetic mean of concentrations reported in the first quarter samples collected from these monitoring wells. The highest concentration for manganese was reported for the groundwater samples collected from monitoring wells 613001 and 613003, and as a result the EPC for manganese was set equal to the

Table 10.7.18
Determination of Groundwater EPCs
SWMU 175 and AOCs 613 and 615
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Parameter	Average Detected Concentration (mg/L)	Maximum Concentration (mg/L)	Average Concentration in Plume* (mg/L)	EPC (mg/L)	
Inorganics					
Aluminum (Al)	4.24	20	13.2	13.2	Mean in Plume #1
Arsenic (As)	0.014	0.072	0.036	0.036	Mean in Plume #1
Beryllium (Be)	0.0015	0.0019	0.0019	0.0019	Mean in Plume #2
Cadmium (Cd)	0.0013	0.0027	0.0027	0.0027	Mean in Plume #3
Chromium (Cr)	0.012	0.0427	0.027	0.027	Mean in Plume #1
Lead (Pb)	0.011	0.0333	0.022	0.022	Mean in Plume #1
Manganese (Mn)	1.24	6.02	5.04	5.04	Mean in Plume #4
Thallium (Tl)	0.0045	0.0069	0.0045	0.0045	Mean in Plume #1
Vanadium (V)	0.016	0.0683	0.035	0.035	Mean in Plume #1
Zinc (Zn)	0.19	1.44	0.50	0.50	Mean in Plume #1
Semivolatile Organics					
Acenaphthene	210	210	210	210	Mean in Plume #5
bis(2-Ethylhexyl)phthalate	40	40	40	40	Mean in Plume #5
Fluorene	170	340	340	340	Mean in Plume #5
2-Methylnaphthalene	2400	2400	2400	2400	Mean in Plume #5
Phenanthrene	570	570	570	570	Mean in Plume #5
Pyrene	24	24	24	24	Mean in Plume #5
Volatile Organics					
Benzene	3.8	3.8	3.8	3.8	Mean in Plume #5
Chloromethane	0.0020	0.002	0.0020	0.0020	Mean in Plume #6
1,2-Dichloroethene (total)	0.010	0.024	0.024	0.024	Mean in Plume #7
Tetrachloroethene	0.0020	0.002	0.0020	0.0020	Mean in Plume #7
Toluene	1.2	4.9	4.9	4.9	Mean in Plume #5
Trichloroethene	0.0030	0.003	0.0030	0.0030	Mean in Plume #7

* - Arithmetic mean in the most concentrated area of the plume as defined by (assume ½ SQL for nondetects):
Plume #1 - First quarter data from monitoring wells GEL007, GEL008, GEL011
Plume #2 - First quarter data from monitoring wells 613001, GEL008
Plume #3 - First quarter data from monitoring well GEL011
Plume #4 - First quarter data from monitoring wells 613001, 613003
Plume #5 - First quarter data from monitoring well GEL014
Plume #6 - First quarter data from monitoring well 613007
Plume #7 - First quarter data from monitoring well 613004

arithmetic mean of concentrations reported in the first quarter samples collected from these monitoring wells. The highest concentrations of chlorinated VOCs were reported in groundwater samples collected from either monitoring well 613004 (1,2-dichloroethene, tetrachloroethene, and trichloroethene) or GEL007 (chloromethane). As a result, their EPCs were set equal to the concentration reported for the first quarter groundwater samples collected from these COPC's respective monitoring wells.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.7.19 and 10.7.20, respectively.

Groundwater

CDIs for the groundwater pathway are shown in Table 10.7.21.

10.7.7.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.7.22 presents toxicological information specific to each COPC identified at combined AOC 613. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Acenaphthene is a hydrocarbon. In 1989, the USEPA conducted an oral subchronic study on the effects of acenaphthene on mice. Four groups of CD-1 mice were given daily doses of 0, 175, 350, or 700 mg/kg-day acenaphthene for 90 days. The toxicological evaluations of this study included body weight changes, food consumption, mortality, clinical weights, and histopathological evaluations of target organs. The results of this study indicated no treatment-related effects on survival, clinical signs, body weight changes, total food intake, and

Table 10.7.19
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
SWMU 175 and AOCs 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Semivolatile Organics							
Benzo(a)pyrene equivalents	1	0.77	1.1E-06	9.8E-06	1.2E-06	3.8E-07	1.3E-07
Inorganics							
Aluminum (Al)	1	14050	1.9E-02	1.8E-01	2.2E-02	6.9E-03	2.5E-03
Arsenic (As)	1	13.1	1.8E-05	1.7E-04	2.0E-05	6.4E-06	2.3E-06
Beryllium (Be)	1	0.84	1.2E-06	1.1E-05	1.3E-06	4.1E-07	1.5E-07
Chromium (Cr)	1	26.2	3.6E-05	3.3E-04	4.1E-05	1.3E-05	4.6E-06
Manganese (Mn)	1	328	4.5E-04	4.2E-03	5.1E-04	1.6E-04	5.7E-05
Thallium (Tl)	1	0.53	7.2E-07	6.7E-06	8.2E-07	2.6E-07	9.2E-08
Vanadium (V)	1	44.6	6.1E-05	5.7E-04	7.0E-05	2.2E-05	7.8E-06

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.7.20
Chronic Daily Intakes
Dermal Contact with Surface Soil
SWMU 175 and AOCs 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Semivolatile Organics								
Benzo(a)pyrene equivalents	1	0.77	0.01	4.3E-07	1.4E-06	2.7E-07	3.1E-07	1.1E-07
Inorganics								
Aluminum (Al)	1	14050	0.001	7.9E-04	2.6E-03	4.9E-04	5.6E-04	2.0E-04
Arsenic (As)	1	13.1	0.001	7.3E-07	2.4E-06	4.6E-07	5.2E-07	1.9E-07
Beryllium (Be)	1	0.84	0.001	4.7E-08	1.6E-07	3.0E-08	3.4E-08	1.2E-08
Chromium (Cr)	1	26.2	0.001	1.5E-06	4.9E-06	9.2E-07	1.1E-06	3.8E-07
Manganese (Mn)	1	328	0.001	1.8E-05	6.1E-05	1.2E-05	1.3E-05	4.7E-06
Thallium (Tl)	1	0.53	0.001	3.0E-08	9.8E-08	1.9E-08	2.1E-08	7.5E-09
Vanadium (V)	1	44.6	0.001	2.5E-06	8.3E-06	1.6E-06	1.8E-06	6.4E-07

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
\- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.7.21
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
SWMU 175 and AOC 613 and 615
Naval Base Charleston Zone F
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics						
Aluminum (Al)	13.2	3.62E-01	8.44E-01	1.99E-01	1.29E-01	6.35E-02
Arsenic (As)	0.036	9.74E-04	2.27E-03	5.35E-04	3.48E-04	1.71E-04
Beryllium (Be)	0.0019	5.07E-05	1.18E-04	2.79E-05	1.81E-05	8.90E-06
Cadmium (Cd)	0.0027	7.40E-05	1.73E-04	4.07E-05	2.64E-05	1.30E-05
Chromium (Cr)	0.027	7.26E-04	1.69E-03	3.99E-04	2.59E-04	1.28E-04
Lead (Pb)	0.022	6.10E-04	1.42E-03	3.36E-04	2.18E-04	1.07E-04
Manganese (Mn)	5.04	1.38E-01	3.22E-01	7.59E-02	4.93E-02	2.42E-02
Thallium (Tl)	0.0045	1.23E-04	2.87E-04	6.76E-05	4.39E-05	2.16E-05
Vanadium (V)	0.035	9.49E-04	2.21E-03	5.22E-04	3.39E-04	1.67E-04
Zinc (Zn)	0.50	1.38E-02	3.22E-02	7.60E-03	4.93E-03	2.43E-03
Semivolatile Organics						
Acenaphthene	210	5.75E+00	1.34E+01	3.16E+00	2.05E+00	1.01E+00
bis(2-Ethylhexyl)phthalate	40	1.10E+00	2.56E+00	6.03E-01	3.91E-01	1.93E-01
Fluorene	340	9.32E+00	2.17E+01	5.12E+00	3.33E-00	1.64E+00
2-Methylnaphthalene	2400	6.58E+01	1.53E+02	3.62E+01	2.35E-01	1.16E+01
Phenanthrene	570	1.56E+01	3.64E+01	8.59E+00	5.58E-00	2.74E+00
Pyrene	24	6.58E-01	1.53E+00	3.62E-01	2.35E-01	1.16E-01
Volatile Organics						
Benzene	3.8	1.04E-01	2.43E-01	5.73E-02	3.72E-02	1.83E-02
Chloromethane	0.002	5.48E-05	1.28E-04	3.01E-05	1.96E-05	9.63E-06
1,2-Dichloroethene (total)	0.024	6.58E-04	1.53E-03	3.62E-04	2.35E-04	1.16E-04
Tetrachloroethene	0.002	5.48E-05	1.28E-04	3.01E-05	1.96E-05	9.63E-06
Toluene	4.9	1.34E-01	3.13E-01	7.38E-02	4.79E-02	2.36E-02
Trichloroethene	0.003	8.22E-05	1.92E-04	4.52E-05	2.94E-05	1.44E-05

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 16.7.22
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 175 and AOCs 613 and 615
NAVBASE - Charleston

Chemical	Non-Carcinogenic Toxicity Data: Oral Reference Dose (mg/kg day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Carcinogenic Toxicity Data: Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
1,2-Dichloroethene (total)	0.009	b	L	increased serum phosphatase	1,000	NA		NA	NA	NA	NA		NA		D	NA
Acenaphthene	0.06	a	L	hepatotoxicity	3000	NA		NA	NA	NA	NA		NA		NA	NA
Aluminum	1	d	NA	NA	NA	NA		NA	NA	NA	NA		NA		NA	NA
Arsenic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
Benzo(a)pyrene equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	6.1	e	B2	mutagen
Benzene	ND				NA	0.00171	e	NA	NA	NA	0.029	a	0.029	a	A	leukemia
Beryllium	0.005	a	L	microscopic organ changes	100	NA		NA	NA	NA	4.3	a	8.4	a	B2	osteosarcoma
Cadmium (water)	0.0005	a	H	proteinuria	10	NA		NA	NA	NA	NA		6.3	a	B1	lung
Chloroethane	0.257		H	hepatotoxicity	300	0.257		H	hepatotoxicity	NA	0.012	b	0.0063	b	C	kidney tumors
Chromium III	1	a	L	NA	100/10	5.71E-07	e	NA	NA	NA	NA		NA	a	D	NA
Chromium VI	0.005	a	L	NA	300	NA		NA	NA	NA	NA		42	a	A	lung
Lead	NA		NA	NA	NA	NA		NA	NA	NA	NA		NA		B2	various
Manganese	0.047	a	NA	neurological effects	1	0.0000143	a	M	neurological effects	1000	NA		NA		D	NA
Manganese (food)	0.047	a	NA	neurological effects	1	NA		NA	NA	NA	NA		NA		D	NA
Manganese (water)	0.023	a	NA	neurological effects	1	1.43E-05	e	M	neurological effects	1000	NA		NA		D	NA
2-Methylnaphthalene	0.04	f	NA	NA	NA	NA		NA	NA	NA	NA		NA		D	NA
Phenanthrene	0.03		L	kidney effects	3000	NA		NA	NA	NA	NA		NA		D	NA
Tetrachloroethene	0.01	e	M/L	hepatotoxicity in mice, weight gain in rats	1,000	NA		NA	NA	NA	0.052	d	0.00203	d	NA	NA
Thallium	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA		NA		D	NA
Trichloroethane	0.006	e	NA	NA	NA	NA		NA	NA	NA	NA		0.006	e	B2	forestomach tumors in mice
Vanadium	0.007	a	NA	unclear	100	NA		NA	NA	NA	NA		NA		D	NA
Zinc	0.3	a	M	decreased enzyme levels	3	NA		NA	NA	NA	NA		NA		D	NA
bis(2-Ethylhexyl)phthalate	0.02	a	M	increased liver weight	1,000	NA		NA	NA	NA	0.014	a	NA		B2	hepatoma

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = HEAST alternative method
d = EPA NCEA - Cincinnati (provisional)
e = Withdrawn from IRIS/HEAST
f = Information collected from IRIS, based on naphthalene
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

ophthalmological alterations. Liver weight changes accompanied by microscopic alterations (cellular hypertrophy) were noted in both mid- and high-dose animals and seemed to be dose-dependent. Additionally, high-dose males and mid- and high-dose females showed significant increases in cholesterol levels. Although increased liver levels were also observed at the low dose, this change was considered to be adaptive and was not considered adverse. The LOAEL is 350 mg/kg-day based on hepatotoxicity; the NOAEL is 175 mg/kg-day. The oral RfD for acenaphthene is 6E-02. An uncertainty factor of 3,000 reflects 10 each for inter- and intraspecies variability, 10 for the use of a subchronic study for chronic RfD derivation, and 3 for the lack of adequate data in a second species and reproductive/developmental data (IRIS).

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation and indicates aluminum could affect the uptake of other chemicals. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen, et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based SMCL for drinking water is 50 to 200 μg/L.

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. As listed in IRIS the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Benzene is a VOC which has been associated with leukemia. This chemical has been used as a solvent in coal tar naphtha, rubber, and plastic cement. USEPA lists benzene as a group A carcinogen. In large doses, benzene depresses the CNS, and chronic exposure depresses bone marrow. The oral SF for benzene was set by USEPA as 2.9E-02 $(mg/kg\text{-}day)^{1}$; an oral RfD of 0.003 has been set. Occupational inhalation exposure to benzene is acceptable by the Occupational Safety and Health Administration (OSHA) at concentrations of 3.25 milligrams per cubic meter $(mg/m)^3$ or 1 ppm in air (Dreisbach et al; 1987; NIOSH, 1990).

Benzo(a)pyrene equivalents include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01

Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which arc subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per µg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

Other PAHs — those not classified by USEPA as carcinogens — are toxic to the liver, kidney and blood. This group of PAHs includes compounds such as *pyrene*, *acenaphthylene*, *benzo(g,h,i)perylene*, and *phenanthrene*. USEPA determined RfDs for only two of these compounds: pyrene's RfDo of 0.03 mg/kg-day is also used as a surrogate RfDo for phenanthrene. The RfDo for acenaphthene was 0.06 mg/kg-day.

Beryllium exposure via the inhalation route can inflame the lungs, a condition known as Acute Beryllium Disease, as a result of short-term exposure to high concentrations. Removal from exposure reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined an NOAEL of 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. Human epidemiology studies of beryllium are inadequate. As listed in IRIS, classification is based on beryllium being shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. An inhalation SF of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS, the classification is based on limited evidence from occupational epidemiologic studies consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1.

Chloromethane is a clear, colorless gas that has a faintly sweet, nonirritating odor at high levels in the air. A naturally occurring chemical, it is made in large amounts in the oceans and is produced by some plants and rotting wood and when such materials as grass, wood, charcoal, and coal burn. Chloromethane is also produced industrially, but most of it is destroyed during use. It is used mainly in the production of other chemicals such as silicones (72%), agricultural chemicals (8%), quaternary mines, and butyl rubber.

Case reports of humans exposed acutely to high concentrations of chloromethane have described severe neurological effects, sometimes followed by death. Effects on the cardiovascular system, liver, and kidney have also been described in the case reports of humans exposed for brief periods or for more prolonged periods occupationally (Gummart, 1961; McNally, 1946; Spevak et al., 1976). Numerous acute inhalation studies have identified the liver and kidney as target organs in rats and mice, the spleen in mice and dogs, and the testes and epididymides as target organs in rats. These studies have shown that species differences in susceptibility exist and that generally animals are more susceptible to relatively low exposures given continuously than to relatively high exposures given intermittently (ATSDR, 1990). USEPA has ranked chloromethane as a group C carcinogen (USEPA, 1993). Chloromethane has an oral SF as well as an inhalation SF that are 1.3E-02 and 6.3E-03 mg/kg-day, respectively (USEPA, 1996f).

Chromium exists in two stable, natural forms: trivalent (III) and hexavalent (VI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only hexavalent chromium is believed to be carcinogenic by inhalation (IRIS, 1995). Oral RfD values for both forms of chromium are 1.0 and 5E-3 (mg/kg-day). For trivalent chromium, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, hexavalent chromium is considered a group A carcinogen for inhalation exposures, and a SFo of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for chromium (III). The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for chromium (VI). The uncertainty factor was 500 and the modifying factor was 1.

1,2-Dichloroethene is a halogenated hydrocarbon associated with toxicity to the mucous membrane, skin, lung, cornea (irritation), and liver. This compound is less toxic than its alkane counterparts, and is neither mutagenic nor carcinogenic. There is no USEPA carcinogenicity listing for this compound (Dreisbach et al., 1987). However, the RfDo has been set to 1E-02 mg/kg-day for the cis-isomer, and at 2E-02 mg/kg-day for the trans-isomer by USEPA (USEPA 1996f and IRIS, 1996).

bis(2-Ethylhexyl)phthalate, otherwise known as BEHP, is a plasticizer used in virtually every major product category. Phthalate esters are ubiquitously distributed in the environment. Although the toxicity of this compound is relatively low, it is a carcinogen. Reproductive effects are also possible (indicated in animal studies) due to chronic exposure to BEHP. This compound is classified as a B2 carcinogen, and USEPA set the RfDo and SFo to 0.02 mg/kg-day and 0.014 $(mg/kg\text{-}day)^{-1}$, respectively (Klaassen et al., 1986).

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil protective of child residents has been proposed by USEPA Region IV: 400 mg/kg. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. As listed in IRIS, the classification is base on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate – sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from soil and water. In addition, the body is roughly twice as efficient absorbing manganese in water compared to manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA – one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

Naphthalene and ***2-methylnaphthalene*** cause hemolysis with subsequent blocking of renal tubules by precipitated hemoglobin. Hepatic necrosis has been reported. Hemolysis only occurs in individuals with a hereditary deficiency of glucose-6-phosphate dehydrogenase in the red cells (primarily black males), which results in a low level of reduced glutathione and increased susceptibility to hemolysis by metabolites of naphthalene. The fatal dose of ingested naphthalene is approximately 2 grams. These chemicals are most dangerous in children up to age 6, in whom absorption occurs rapidly. The exposure limit for naphthalene is 10 ppm (Dreisbach et al., 1987). The RfDo for naphthalene is 4E-02 mg/kg-day (USEPA ,1996f).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's RfDo for Thallium is 0.00008 mg/kg-day (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

Tetrachloroethene (PCE) has been used as a solvent in industry and occurs as a volatile constituent in other chlorinated hydrocarbons. Tetrachloroethene exposure can result in long-lasting narcosis with delayed onset and damage to the liver and kidneys. The principal manifestations of overexposure to this halogenated hydrocarbon are coma, jaundice, oliguria, and irritation of the eyes and nose followed by headache and nausea. Cyanosis and CNS depression progressing to coma appear one to four hours after the short-term exposure. Liver and kidney damage after apparent recovery or after repeated exposures cause acute symptoms as nausea, vomiting, abdominal pain, jaundice, oliguria, and uremia. PCE exposure via the inhalation and/or skin absorption exposure pathways could result in headache, tremor, dizziness, peripheral paresthesia, hypesthesia or anesthesia. PCE is a carcinogen, but is currently under review by USEPA; it is currently classified as a B2-C carcinogen. The RfDo has been set to 0.01 mg/kg-day, and the SFo and SFi have been set to 0.052 and 0.0023 $(mg/kg\text{-}day)^{-1}$, respectively, by USEPA (Dreisbach et al., 1987). An oral RfD uncertainty factor of 1000 has been issued for PCE as well as a modifying factor of 1 (IRIS, 1996).

Trichloroethene is a mobile, volatile liquid which has the characteristic odor of chloroform. Inhalation, intravenous, and subcutaneous routes are all viable exposure pathways for this compound. TCE is a strong skin and eye irritant that is relatively less toxic if ingested. Inhaling high concentrations causes narcosis and anesthesia. This compound targets the liver and other organs. TCE is a B2 carcinogen, and the SFo and SFi have been set by USEPA to 0.011 and 0.006 $(mg/kg\text{-}day)^{-1}$, respectively. USEPA also set the RfDo to 0.006 mg/kg-day (Dreisbach et al., 1987).

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The RfDo set by USEPA is 0.007 mg/kg-day.

Zinc is an essential, ubiquitous element present in food, water, and soil. The average American daily intake is approximately 12 to 15 mg, and thc rccommended daily allowance is 15 mg. Excessive exposure to zinc is relatively uncommon and requires exposure to high concentrations. This element does not accumulate under chronic exposure conditions, and body content is self-regulated by zinc liver concentrations and absorption mechanisms. Inhaling zinc dust can cause metal fume fever, and the primary effect of zinc ingestion (at toxic concentrations) is gastrointestinal disturbance and irritation. Other effects on the blood, liver, and kidney are possible at higher concentrations. Twelve grams of elemental zinc per day were not shown to elicit effects other than gastrointestinal disturbances over two days (or 48 hours). Experimental animals have been given 100 times the dietary requirements without discernible effects. USEPA determined that the RfDo is 0.3 mg/kg-day (Klaassen et al., 1986).

10.7.7.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residcnts, hazard was computed separately to address child and adult exposure. Tables 10.7.23 and 10.7.24 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Table 10.7.23
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 175 and AOCs 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Semivolatile Organics							
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	8.8E-06	ND	9.8E-07
Inorganics							
Aluminum (Al)	1	NA	0.019	0.18	ND	0.0069	ND
Arsenic (As)	0.0003	1.5	0.060	0.56	3.1E-05	0.021	3.4E-06
Beryllium (Be)	0.005	4.3	0.00023	0.0022	5.7E-06	0.000082	6.3E-07
Chromium (Cr)	0.005	NA	0.0072	0.067	ND	0.0026	ND
Manganese (Mn)	0.047	NA	0.010	0.089	ND	0.0034	ND
Thallium (Tl)	8E-05	NA	0.0090	0.084	ND	0.0032	ND
Vanadium (V)	0.007	NA	0.0087	0.081	ND	0.0031	ND
SUM Hazard Index/ILCR			0.1	1	5E-05	0.04	5E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.7.24
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 175 and AOC 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Semivolatile Organics								
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	3.9E-06	ND	1.6E-06
Inorganics								
Aluminum (Al)	0.2	0.2	NA	0.0039	0.013	ND	0.0028	ND
Arsenic (As)	0.2	6E-05	7.5	0.012	0.040	3.4E-06	0.009	1.4E-06
Beryllium (Be)	0.2	0.001	21.5	0.000047	0.00016	6.4E-07	0.000	2.6E-07
Chromium (Cr)	0.2	0.001	NA	0.0015	0.0049	ND	0.0011	ND
Manganese (Mn)	0.2	0.0094	NA	0.0020	0.0065	ND	0.0014	ND
Thallium (Tl)	0.2	1.6E-05	NA	0.0018	0.0061	ND	0.0013	ND
Vanadium (V)	0.2	0.0014	NA	0.0018	0.0059	ND	0.0013	ND
SUM Hazard Index/ILCR				0.02	0.08	8E-06	0.02	3E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for combined AOC 613 surface soils is 5E-05. The dermal pathway ILCR is 8E-06. Arsenic and BEQs were the primary contributors to ILCR projections for the ingestion and dermal pathways, accounting for close to 90% of the cumulative soil pathway risk. Beryllium was a secondary contributors to the ingestion pathway.

The ingestion HIs projected for the adult and child receptors are 0.1 and 1, respectively. The dermal pathway HIs were 0.02 for the adult resident receptor and 0.08 for the child resident receptor. Arsenic and aluminum were the primary contributor to hazard index projections for the ingestion pathway.

Hypothetical Site Workers

Site worker ILCRs are 5E-06 for the ingestion pathway and 3E-06 for the dermal contact pathway. Arsenic was the primary contributor to risk for both pathways, while BEQs were secondary contributors to the dermal pathway.

Site worker HIs are 0.04 for the ingestion pathway and 0.02 for the dermal pathway.

Groundwater Pathways

Exposure to groundwater onsite was evaluated under a residential and site worker scenarios based on the results of the first quarter sampling event. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from thc surficial aquifer, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Tables 10.7.25 and 10.7.26 present the risk and hazard for the ingestion and inhalation pathways, respectively.

Table 10.7.25
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
SWMU 175 and AOC 613 and 615
Naval Base Charleston Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics							
Aluminum (Al)	1	NA	0.36	0.84	ND	0.13	ND
Arsenic (As)	0.0003	1.5	3.2	7.6	8.0E-04	1.2	2.6E-04
Beryllium (Be)	0.005	4.3	0.010	0.024	1.2E-04	0.0036	3.8E-05
Cadmium (Cd)	0.0005	NA	0.15	0.35	ND	0.053	ND
Chromium (Cr)	0.005	NA	0.15	0.34	ND	0.052	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Manganese (Mn)	0.023	NA	6.0	14	ND	2.1	ND
Thallium (Tl)	8E-05	NA	1.5	3.6	ND	0.55	ND
Vanadium (V)	0.007	NA	0.14	0.32	ND	0.048	ND
Zinc (Zn)	0.3	NA	0.046	0.11	ND	0.016	ND
Semivolatile Organics							
Acenaphthene	0.06	NA	96	224	ND	34	ND
bis(2-Ethylhexyl)phthalate	0.02	0.014	55	128	8.4E-03	20	2.7E-03
Fluorene	0.04	NA	233	543	ND	83	ND
2-Methylnaphthalene	0.04	NA	1644	3836	ND	587	ND
Phenanthrene	0.04	NA	390	911	ND	139	ND
Pyrene	0.03	NA	22	51	ND	7.8	ND
Volatile Organics							
Benzene	0.003	0.029	35	81	1.7E-03	12	5.3E-04
Chloromethane	NA	0.013	ND	ND	3.9E-07	ND	1.3E-07
1,2-Dichloroethene (total)	0.009	NA	0.073	0.17	ND	0.026	ND
Tetrachloroethene	0.01	0.052	0.0055	0.013	1.6E-06	0.0020	5.0E-07
Toluene	0.2	NA	0.67	1.6	ND	0.24	ND
Trichloroethene	0.006	0.011	0.014	0.032	5.0E-07	0.0049	1.6E-07
SUM Hazard Index/ILCR			2487	5803	1E-02	888	4E-03

NOTES:

NA Not available
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk

Table 10.7.26
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants in Groundwater Resulting from Domestic Use
SWMU 175 and AOC 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Inhalation RfD Used (mg/kg-day)	Inhalation SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Volatile Organics							
Benzene	0.00171	0.029	61	142	1.7E-03	22	5.3E-04
Chloromethane	NA	0.0063	ND	ND	1.9E-07	ND	6.1E-08
1,2-Dichloroethene (total)	0.009	NA	0.073	0.17	ND	0.026	ND
Tetrachloroethene	0.01	0.00203	0.0055	0.013	6.1E-08	0.0020	2.0E-08
Toluene	0.114	NA	1.2	2.7	ND	0.42	ND
Trichloroethene	0.006	0.006	0.014	0.032	2.7E-07	0.0049	8.7E-08
SUM Hazard Index/ILCR			62	145	2E-03	22	5E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Hypothetical Site Residents

The projected ILCR for the future residential scenario is 1E-02 for the ingestion pathway and 2E-03 for the inhalation pathway. Benzene and bis(2-ethyhexyl)phthalate were the primary contributors to risk projections for both pathways, accounting for approximately 95% of the cumulative risk for the groundwater pathway. Arsenic, beryllium, and PCE were secondary contributors to ILCR projections for the groundwater ingestion pathway.

The projected hazard indices for the adult and child resident are 2,487 and 5,803, respectively, for the ingestion pathway. Acenaphthene, benzene, bis(2-ethylhcxyl)phthalate, fluorene, manganese, 2-methylnaphthalene, phenanthrene, and pyrene were primary contributors to the ingestion pathway, accounting for nearly 100% of the projected HI estmates for the ingestion pathway. Aluminum, arsenic, cadmium, chromium, 1,2-dichloroethene (total), thallium, toluene, vanadium, and zinc were secondary contributors to the ingestion pathway. The projected hazard indices for the adult and child resident are 62 and 145 for the inhalation pathway. Benzene was the primary contributor for the inhalation pathway, accounting for over 97% of the projected HI estimates. Toluene and 1,2-dichloroethene were secondary contributors to HI projections for the inhalation pathway.

Hypothetical Site Workers

The projected groundwater ingestion pathway ILCR for the site worker scenario is 4E-03. Benzene and bis(2-ethylhexyl)phthlate were the primary contributors to both pathways, accounting for approximately 97% of the cumulative risk for the groundwater pathways. Arsenic and beryllium were secondary contributors to risk projections for the ingestion pathway.

The projected site worker HI for the groundwater ingestion pathway is 888. Acenapthene, benzene, bis(2-ethyhexyl)phthalate, fluorene, 2-methylnaphthalene, phenanthrene, and pyrene were primary contributors to projected HIs for the groundwater ingestion pathway, and aluminum, arsenic, manganese, thallium, and toluene were secondary contributors to the ingestion pathway. The projected site worker HI for the inhalation pathway is 22. Benzene was the primary contributor to the inhalation pathway, and toluene was a secondary contributor.

Current Site Workers

Groundwater is not currently used as a source for potable or process water at combined AOC 613 or other areas of Zone F. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

Lead Toxicity

Background

Currently, USEPA has not established an oral SF or reference dose for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood levels as low as 10 μg/dL.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Uptake/Biokinetics Model (Version 0.99d) (Lead Model) to predict mean blood lead levels in children based on exposure to impacted environmental media. The model was used to assess the potential health effects of elevated lead levels reported in groundwater at combined AOC 613.

Future Residential Scenario

The Lead Model default concentrations are used for exposure to air (0.1 Pb grams per cubic meter [g/m^3]) and maternal blood lead level (2.5 Pb per μg/dL). In the case of combined AOC 613 surface soil, the maximum reported concentration (103 mg/kg) did not exceed the 400 mg/kg cleanup level established for lead. As a result, the maximum lead surface soil concentration was averaged with the lead concentrations from adjacent surface soil samples representing an area of approximately one-half acre (613SP044, 613SP045, 613SP051, 613SP052, 613SP053 ,613SP065, 613SP066, 613SP067, 613SP068). The average lead concentration of this "worst case" half acre parcel (57.8 mg/kg) was used as the input for soil and house dust. The arithmetic mean groundwater concentration of lead (22 μg/L) in the most concentrated area of the plume (as defined by the first quarter groundwater samples collected from monitoring well GEL008 and GEL011) was used as the input for drinking water. The Lead Model was run for a child ages 0-7 years using the inputs listed above. Table 10.7.27 summarizes the Lead Model results under these exposure conditions.

Figure 10.7-38 shows the probability percentage of blood lead levels for a child 0 to 7 years old. Based on this model output using the mean soil lead concentration in the "worst case half-acre" and mean groundwater concentration in the most concentrated area of the plume, the geometric mean blood concentrations is estimated to be 3.5 μg/dL, and the probability of blood lead concentration exceeding 10 μg/dL is 1.23%. USEPA generally considers that media concentrations resulting in probability percentage estimates of 5% or less sufficiently protect potential child receptors. As a result, groundwater lead would not require corrective action under this hypothetical exposure scenario.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06

Table 10.7.27
Lead Model Results - SWMU 175 and AOC 613 and 615
NAVBASE - Charleston, Zone F
Charleston, South Carolina

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT
DRINKING WATER Conc: 22.00 ug Pb/L

WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	57.8	57.8
1-2	57.8	57.8
2-3	57.8	57.8
3-4	57.8	57.8
4-5	57.8	57.8
5-6	57.8	57.8
6-7	57.8	57.8

Additional Dust Sources: None DEFAULT
PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	3.3	6.03	1.38	2.58	2.05	0.00	0.02
1-2:	4.0	9.87	2.15	2.65	5.04	0.00	0.03
2-3:	3.9	10.52	2.16	3.00	5.29	0.00	0.06
3-4:	3.7	10.62	2.19	2.92	5.45	0.00	0.07
4-5:	3.4	10.27	1.64	2.84	5.72	0.00	0.07
5-6:	3.3	10.65	1.48	3.01	6.06	0.00	0.09
6-7:	3.1	11.01	1.40	3.33	6.18	0.00	0.09

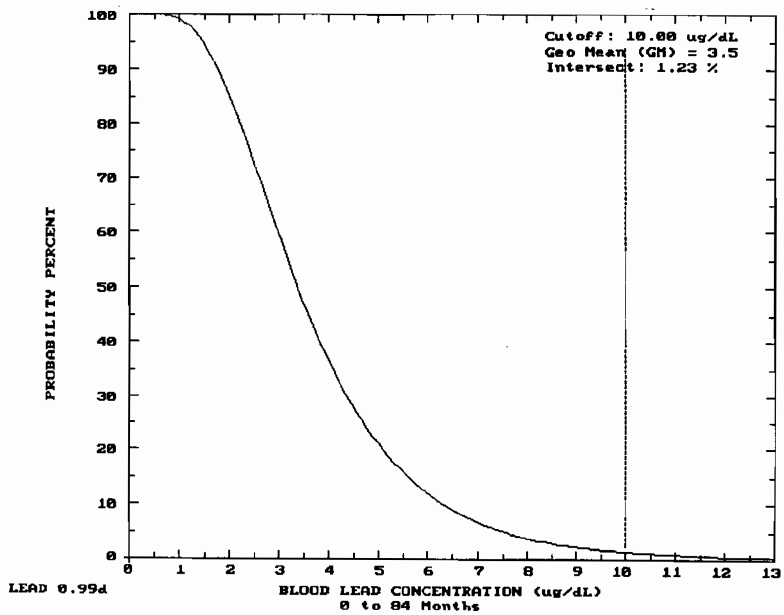


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FIGURE 10.7-38

PROBABILITY DISTRIBUTION OF BLOOD LEAD LEVELS FOR CHILD 0-7 YEARS - RESIDENTIAL SCENARIO - SWMU 175 AND AOC 613 & 618

Date: 16 DEC 97 | DWG Name: 29FRFILJ

or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.7.28 presents the COCs identified for combined AOC 613 surface soil and groundwater.

Surface Soils

Future Site Residents

BEQs, arsenic, and beryllium were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections. Aluminum and arsenic were identified as COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

BEQs and arsenic were identified as soil pathway COCs based on their contribution to cumulative industrial ILCR projections.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion, residential soil RBCs and background concentrations were compared to each reported COC concentration. BEQs were detected in 15 of 65 surface soil samples at concentrations above its residential RBC (88 μg/kg). Arsenic was detected at concentrations exceeding its RBC (0.43 mg/kg) in all 65 surface soil samples; however, arsenic exceeded its background value (19.9 mg/kg) in eight surface soil samples. Beryllium was detected at concentrations exceeding its RBC (0.15 mg/kg) in 53 of 65 surface soil samples. Beryllium exceeded its background value (1.05 mg/kg) in 12 surface soil samples. Aluminum was detected at concentrations exceeding its

Table 10.7.28
Summary of Risk and Hazard-based COCs
SWMU 175 and AOC 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Semivolatile Organics**						
		Benzo(a)pyrene equivalents	ND	ND	8.8E-06	ND	9.8E-07	2
		Inorganics						
		Aluminum (Al)	0.019	0.18	ND	0.0069	ND	1
		Arsenic (As)	0.060	0.56	3.1E-05	0.021	3.4E-06	1 2 4
		Beryllium (Be)	0.00023	0.0022	5.7E-06	0.000082	6.3E-07	2
		Chromium (Cr)	0.0072	0.067	ND	0.0026	ND	
		Manganese (Mn)	0.010	0.089	ND	0.0034	ND	
		Thallium (Tl)	0.0090	0.084	ND	0.0032	ND	
		Vanadium (V)	0.0087	0.081	ND	0.0031	ND	
	Dermal	**Semivolatile Organics**						
		Benzo(a)pyrene equivalents	ND	ND	3.9E-06	ND	1.6E-06	2 4
		Inorganics						
		Aluminum (Al)	0.0039	0.013	ND	0.0028	ND	
		Arsenic (As)	0.012	0.040	3.4E-06	0.0087	1.4E-06	2 4
		Beryllium (Be)	0.000047	0.00016	6.4E-07	0.000034	2.6E-07	
		Chromium (Cr)	0.0015	0.0049	ND	0.0011	ND	
		Manganese (Mn)	0.0020	0.0065	ND	0.0014	ND	
		Thallium (Tl)	0.0018	0.0061	ND	0.0013	ND	
		Vanadium (V)	0.0018	0.0059	ND	0.0013	ND	
Surface Soil Pathway Sum			0.1	1	5E-05	0.06	8E-06	

RBC (7,800 mg/kg) in 53 of 65 surface soil samples, and exceeded its background value (18,500 mg/kg) in 11 surface soil samples.

First Quarter Groundwater

Future Site Residents

Arsenic, beryllium, benzene, bis(2-ethylhexyl)phthalate, and PCE were identified as COCs based on their contribution to cumulative groundwater pathway risk projections. Acenaphthene, aluminum, arsenic, benzene, cadmium, chromium, 1,2-dichloroethene (total), bis(2-ethylhexyl)phthalate, fluorene, manganese, 2-methylnaphthalcnc, phcnanthrene, pyrene, thallium, toluene, vanadium, and zinc were identified as COCs based on their contribution to cumulative HI projections.

Future Site Workers

Arsenic, beryllium, benzene, and bis(2-ethylhexyl)phthalate were identified as COCs based on their contribution to cumulative risk projections. Acenaphthene, aluminum, arsenic, benzene, bis(2-ethylhexyl)phthalate, fluorene, manganese, 2-methylnaphthalene, phenanthrene, pyrene, thallium, and toluene were identified as COC based on their contribution to cumulative HI projections.

The highest concentrations of inorganic COC were reported in the first quarter groundwater samples collected from monitoring wells 613001, GEL007, GEL008, and GEL011, located along the southwest perimeter of the site. The only detections of petroleum-related chemicals (acenaphthene, benzene, bis(2-ethylhexyl)phthalate, pyrene, phenanthrene, 2-methylnaphthalene, fluorene, and toluene were reported in the first quarter groundwater sample collected from monitoring well GEL014. The only detections of chlorinated VOCs were reported in the first quarter groundwater samples collected from either monitoring well 613004 or GEL007.

10.7.7.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, since the property is being currently being transferred to the City of Charleston. If this area were to bc uscd as a residential site, the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. The entire site is either paved or is occupied by buildings. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at combined AOC 613 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone F. This system is slated to remain in operation under the current base reuse plan. As a result, groundwater would not be expected to be used under future site use scenarios, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

Exposure point concentrations for soil pathways were set equal to the 95% UCL for each soil COPC. Although the soil sampling grid covered more than six acres comprising many smaller potential exposure unit areas, no "hot spot" or definable areas of grossly elevated concentrations could be defined for any of the soil COPCs. Therefore the 95% UCL was considered to provide a reasonable upper-bound EPC for all potential exposure unit areas for combined AOC 613. UCLs are upper-bound estimates of the true mean of a dataset and commonly results in an overestimation of risk and hazard.

Exposure point concentrations for groundwater were set equal to the arithmetic mean in "the most concentrated area of the plume", which was defined separately for each COPC or group of COPCs. For purposes of conservatism in the risk assessment, these "plumes" were assumed to be colocated, although in some cases they represent different areas of the surficial aquifer. As a result, simultaneous cxposure to each COPC at the EPC is unlikely and this approach would tend to result in an overestimation of risk and hazard.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for combined AOC 613. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard bascd on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration near its RBC (e.g. within 10% of its RBC).

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC).

Second quarter sample results for the groundwater sample collected from monitoring well GEL014 indicated a significant drop in the concentrations of petroleum-related chemicals (acenaphthene, benzene, bis(2-ethylhexyl)phthalate, fluorene, 2-methylnaphthalene, phenanthrene, and pyrene). Acenaphthene, bis(2-ethylhexyl)phthalate, pyrene, and toluene were all reported as nondetects in the second quarter sample. The concentrations of other petroleum related chemicals dropped between two and four orders of magnitude between the first and second quarter sampling events. Similarly, some of the inorganics showed a significant drop in concentration between the first and second quarter groundwater samples. Except for chloromethane, the concentrations of chlorinated volatiles were consistent between first and second quarter sampling events. Since the groundwater risk assessment was based solely on first quarter data, it is highly recommended that subsequent quarterly groundwater data be thouroughly evaluated prior to any risk management decisions based on the results to the groundwater risk assessment.

Groundwater is not currently used as a potable water source at combined AOC 613, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

10.7.7.7 Risk Summary

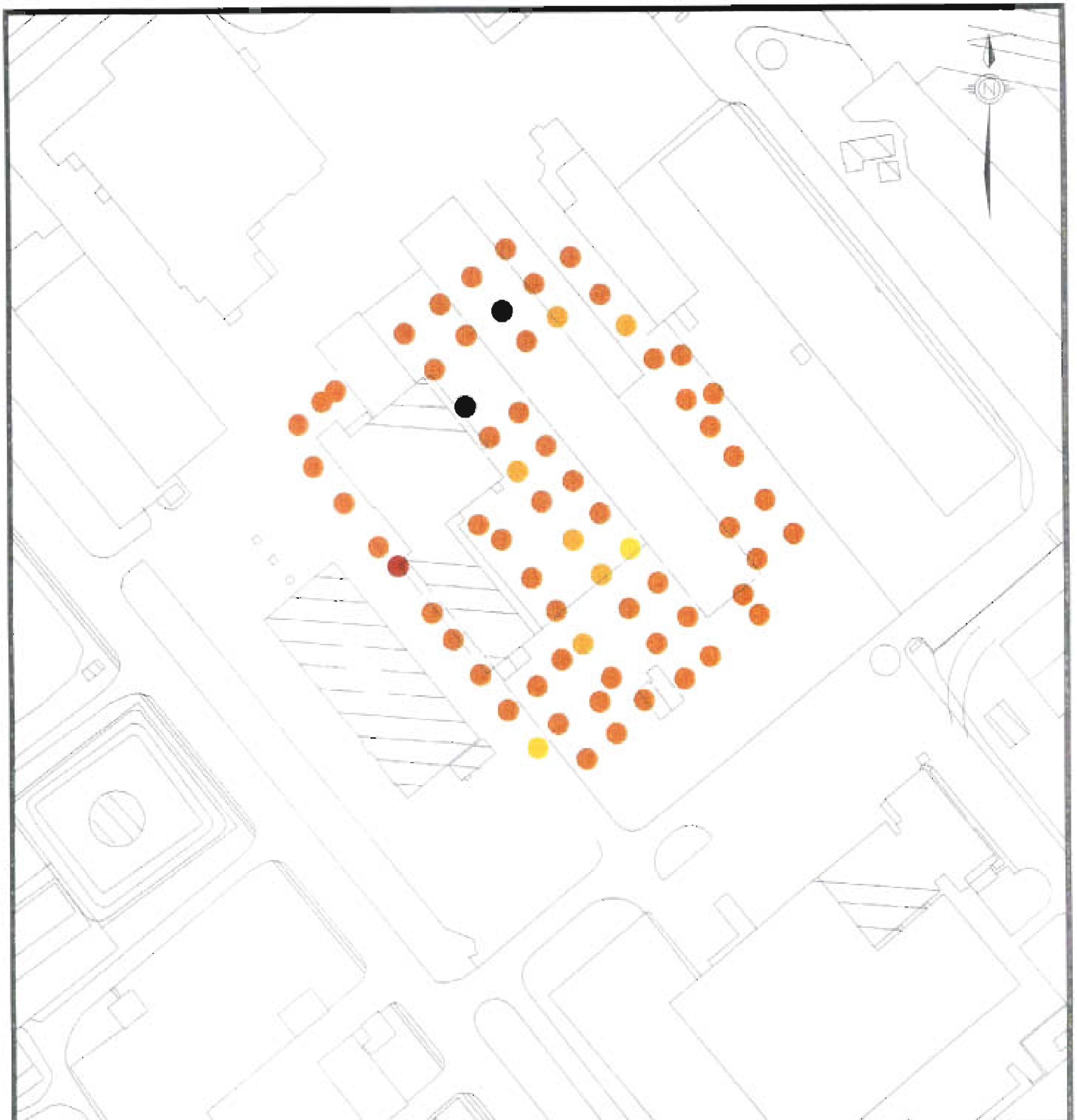
The risk and hazard posed by contaminants at combined AOC 613 were assessed for future site workers and future site residents under reasonable maximum exposure assumptions. For surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. For groundwater the ingestion and inhalation pathways were assessed. Table 10.7.29 presents the risk summary for each pathway/receptor group evaluated for combined AOC 613.

Soil - Residential Scenario

Residential soil pathway COCs identified for combined AOC 613 are aluminum, arsenic, BEQs, and beryllium. Figure 10.7-39 illustrates point risk estimates for combined AOC 613 based on soil exposure pathways under a future residential scenario. Table 10.7.30 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Arsenic and beryllium are the primary contributors to risk, accounting for nearly all of the cumulative risk at each surface soil sample location. BEQs were a significant contributor to risk estimates associated with surface soil sample locations (613SP009, 613SP021, 613SP022, 613SP029, 613SP051, and 613SP061). Risk estimates ranged from 3E-06 (613SB048) to 1E-04 (613SB024). The mean risk estimate is 3E-05.

Figure 10.7-40 illustrates point estimates for hazard at combined AOC 613 based on soil exposure pathways under a future residential scenario. Aluminum, arsenic, chromium, manganese, thallium, and vanadium contributed to hazard estimates above unity at 21 of 65 surface soil locations. Hazard index estimates ranged from 0.1 (613SB039) to 3 (613SB024). The mean hazard estimate is 0.9.



LEGEND

- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 300

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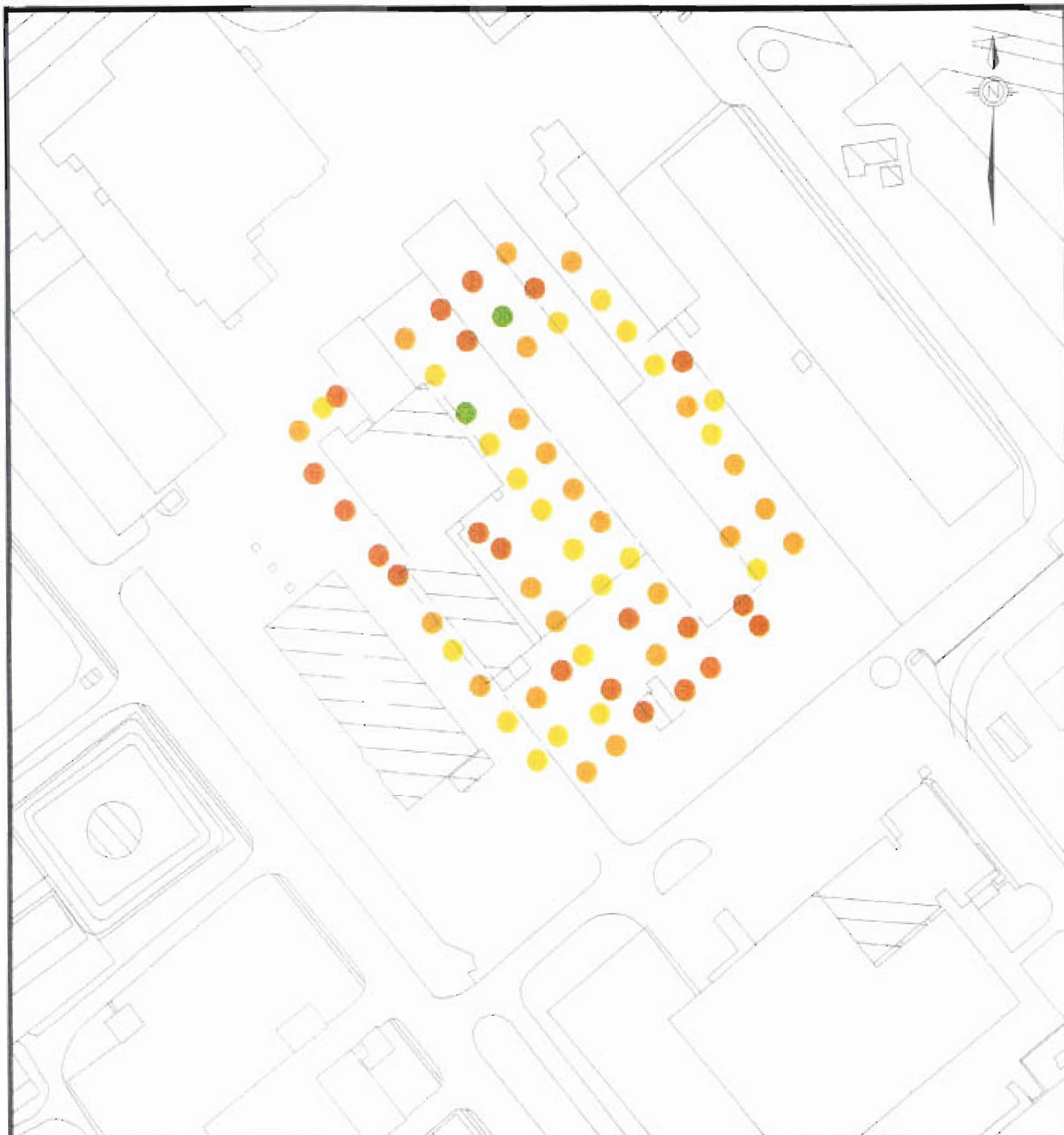
FIGURE 10.7.39
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 175, AOC 613, 615



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 300

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CHARLESTON, S.C.

FIGURE 10.7.40
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 175, AOC 613, 615

Table 10.7.29
Summary of Risk and Hazard
SWMU 175 and AOCs 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.1	1	5E-05	0.04	5E-06
	Dermal Contact	0.02	0.08	8E-06	0.02	3E-06
Sum of Soil Pathways		0.1	1	5E-05	0.06	8E-06
Groundwater	Ingestion	2487	5803	1E-02	888	4E-03
	Inhalation	62	145	2E-03	22	5E-04
Sum of Groundwater Pathways		2487	5803	1E-02	888	4E-03
Sum of All Pathways		2487	5804	1E-02	888	4E-03

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

Table 10.7.30
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 175 and AOCs 613 and 615
NAVBASE - Charleston
Charleston, South Carolina

Location	Parameter	Concentration	Units	Hazard Quotient	% HI	Risk (E-06)	% Risk
613SP001	Aluminum (Al)	14550	mg/kg	0.1995	22.78	NA	
613SP001	Arsenic (As)	7.85	mg/kg	0.3588	40.97	20.5042	84.82
613SP001	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP001	Beryllium (Be)	0.49	mg/kg	0.0013	0.15	3.6690	15.18
613SP001	Chromium (Cr)	25.4	mg/kg	0.0697	7.95	NA	
613SP001	Manganese (Mn)	42.05	mg/kg	0.0123	1.40	NA	
613SP001	Thallium (Tl)	0.875	mg/kg	0.1500	17.12	NA	
613SP001	Vanadium (V)	43	mg/kg	0.0842	9.62	NA	
	Total			0.8758		24.1732	
613SP002	Aluminum (Al)	9460	mg/kg	0.1297	27.22	NA	
613SP002	Arsenic (As)	5.7	mg/kg	0.2605	54.68	14.8884	77.72
613SP002	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP002	Beryllium (Be)	0.57	mg/kg	0.0016	0.33	4.2680	22.28
613SP002	Chromium (Cr)	12.2	mg/kg	0.0335	7.02	NA	
613SP002	Manganese (Mn)	43.3	mg/kg	0.0126	2.65	NA	
613SP002	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP002	Vanadium (V)	19.7	mg/kg	0.0386	8.10	NA	
	Total			0.4765		19.1564	
613SP003	Aluminum (Al)	8620	mg/kg	0.1182	21.93	NA	
613SP003	Arsenic (As)	4.3	mg/kg	0.1965	36.47	11.2316	68.18
613SP003	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP003	Beryllium (Be)	0.7	mg/kg	0.0019	0.36	5.2414	31.82
613SP003	Chromium (Cr)	27.2	mg/kg	0.0746	13.84	NA	
613SP003	Manganese (Mn)	55.3	mg/kg	0.0161	2.99	NA	
613SP003	Thallium (Tl)	0.53	mg/kg	0.0908	16.85	NA	
613SP003	Vanadium (V)	20.8	mg/kg	0.0407	7.56	NA	
	Total			0.5390		16.4730	
613SP004	Aluminum (Al)	23200	mg/kg	0.3181	21.06	NA	
613SP004	Arsenic (As)	17.4	mg/kg	0.7953	52.66	45.4488	80.18
613SP004	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP004	Beryllium (Be)	1.5	mg/kg	0.0041	0.27	11.2316	19.82
613SP004	Chromium (Cr)	41.6	mg/kg	0.1141	7.55	NA	
613SP004	Manganese (Mn)	414	mg/kg	0.1208	8.00	NA	
613SP004	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP004	Vanadium (V)	80.6	mg/kg	0.1579	10.45	NA	
	Total			1.5103		56.6804	
613SP005	Aluminum (Al)	18600	mg/kg	0.2550	17.30	NA	
613SP005	Arsenic (As)	17.5	mg/kg	0.7999	54.27	45.7100	82.44
613SP005	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP005	Beryllium (Be)	1.3	mg/kg	0.0036	0.24	9.7341	17.56
613SP005	Chromium (Cr)	39.1	mg/kg	0.1072	7.28	NA	
613SP005	Manganese (Mn)	650	mg/kg	0.1896	12.87	NA	
613SP005	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP005	Vanadium (V)	60.5	mg/kg	0.1185	8.04	NA	
	Total			1.4739		55.4441	
613SP006	Aluminum (Al)	8650	mg/kg	0.1186	17.60	NA	

613SP006	Arsenic (As)	8.7	mg/kg	0.3977	58.99	22.7244	82.36
613SP006	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP006	Beryllium (Be)	0.65	mg/kg	0.0018	0.26	4.8670	17.64
613SP006	Chromium (Cr)	19.3	mg/kg	0.0529	7.85	NA	
613SP006	Manganese (Mn)	95.6	mg/kg	0.0279	4.14	NA	
613SP006	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP006	Vanadium (V)	38.4	mg/kg	0.0752	11.16	NA	
	Total			0.6741		27.5914	
613SP007	Aluminum (Al)	24800	mg/kg	0.3401	18.78	NA	
613SP007	Arsenic (As)	21.5	mg/kg	0.9827	54.26	56.1580	81.52
613SP007	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP007	Beryllium (Be)	1.7	mg/kg	0.0047	0.26	12.7292	18.48
613SP007	Chromium (Cr)	42.4	mg/kg	0.1163	6.42	NA	
613SP007	Manganese (Mn)	344	mg/kg	0.1003	5.54	NA	
613SP007	Thallium (Tl)	0.73	mg/kg	0.1251	6.91	NA	
613SP007	Vanadium (V)	72.4	mg/kg	0.1418	7.83	NA	
	Total			1.8110		68.8872	
613SP008	Aluminum (Al)	25400	mg/kg	0.3483	22.12	NA	
613SP008	Arsenic (As)	20.2	mg/kg	0.9233	58.64	52.7624	82.45
613SP008	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP008	Beryllium (Be)	1.5	mg/kg	0.0041	0.26	11.2316	17.55
613SP008	Chromium (Cr)	38.4	mg/kg	0.1053	6.69	NA	
613SP008	Manganese (Mn)	234	mg/kg	0.0683	4.34	NA	
613SP008	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP008	Vanadium (V)	63.9	mg/kg	0.1252	7.95	NA	
	Total			1.5744		63.9940	
613SP009	Aluminum (Al)	8030	mg/kg	0.1101	29.73	NA	
613SP009	Arsenic (As)	4	mg/kg	0.1828	49.37	10.4480	66.90
613SP009	B(a)P Equiv.	226.23	ug/kg	NA		3.7464	23.99
613SP009	Beryllium (Be)	0.19	mg/kg	0.0005	0.14	1.4227	9.11
613SP009	Chromium (Cr)	9.2	mg/kg	0.0252	6.81	NA	
613SP009	Manganese (Mn)	87.8	mg/kg	0.0256	6.92	NA	
613SP009	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP009	Vanadium (V)	13.3	mg/kg	0.0261	7.03	NA	
	Total			0.3704		15.6171	
613SP010	Aluminum (Al)	15100	mg/kg	0.2071	17.28	NA	
613SP010	Arsenic (As)	15.6	mg/kg	0.7130	59.50	40.7472	82.25
613SP010	B(a)P Equiv.	105.86	ug/kg	NA		1.7531	3.54
613SP010	Beryllium (Be)	0.94	mg/kg	0.0026	0.22	7.0385	14.21
613SP010	Chromium (Cr)	29.2	mg/kg	0.0801	6.68	NA	
613SP010	Manganese (Mn)	370	mg/kg	0.1079	9.01	NA	
613SP010	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP010	Vanadium (V)	44.8	mg/kg	0.0878	7.32	NA	
	Total			1.1984		49.5388	
613SP012	Aluminum (Al)	23500	mg/kg	0.3222	16.57	NA	
613SP012	Arsenic (As)	26.95	mg/kg	1.2318	63.33	70.3934	84.98
613SP012	B(a)P Equiv.	95.567	ug/kg	NA		1.5826	1.91
613SP012	Beryllium (Be)	1.45	mg/kg	0.0040	0.20	10.8572	13.11
613SP012	Chromium (Cr)	43.25	mg/kg	0.1186	6.10	NA	
613SP012	Manganese (Mn)	461	mg/kg	0.1345	6.91	NA	
613SP012	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP012	Vanadium (V)	68.4	mg/kg	0.1340	6.89	NA	
	Total			1.9451		82.8333	
613SP013	Aluminum (Al)	9350	mg/kg	0.1282	17.28	NA	

613SP013	Arsenic (As)	10.2	mg/kg	0.4662	62.82	26.6424	84.35
613SP013	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP013	Beryllium (Be)	0.66	mg/kg	0.0018	0.24	4.9419	15.65
613SP013	Chromium (Cr)	18.7	mg/kg	0.0513	6.91	NA	
613SP013	Manganese (Mn)	114	mg/kg	0.0333	4.48	NA	
613SP013	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP013	Vanadium (V)	31.3	mg/kg	0.0613	8.26	NA	
	Total			0.7421		31.5843	
613SP014	Aluminum (Al)	21300	mg/kg	0.2921	17.77	NA	
613SP014	Arsenic (As)	21.3	mg/kg	0.9736	59.23	55.6356	84.15
613SP014	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP014	Beryllium (Be)	1.4	mg/kg	0.0038	0.23	10.4828	15.85
613SP014	Chromium (Cr)	41.5	mg/kg	0.1138	6.92	NA	
613SP014	Manganese (Mn)	433	mg/kg	0.1263	7.69	NA	
613SP014	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP014	Vanadium (V)	68.4	mg/kg	0.1340	8.15	NA	
	Total			1.6436		66.1185	
613SP017	Aluminum (Al)	8180	mg/kg	0.1122	17.27	NA	
613SP017	Arsenic (As)	8.9	mg/kg	0.4068	62.62	23.2468	89.87
613SP017	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP017	Beryllium (Be)	0.35	mg/kg	0.0010	0.15	2.6207	10.13
613SP017	Chromium (Cr)	15.8	mg/kg	0.0433	6.67	NA	
613SP017	Manganese (Mn)	90.7	mg/kg	0.0265	4.07	NA	
613SP017	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP017	Vanadium (V)	30.6	mg/kg	0.0599	9.23	NA	
	Total			0.6497		25.8675	
613SP018	Aluminum (Al)	2570	mg/kg	0.0352	15.41	NA	
613SP018	Arsenic (As)	2.9	mg/kg	0.1326	57.98	7.5748	100.00
613SP018	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP018	Beryllium (Be)	ND	mg/kg	NA		NA	
613SP018	Chromium (Cr)	6.3	mg/kg	0.0173	7.56	NA	
613SP018	Manganese (Mn)	109	mg/kg	0.0318	13.91	NA	
613SP018	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP018	Vanadium (V)	6	mg/kg	0.0118	5.14	NA	
	Total			0.2286		7.5748	
613SP019	Aluminum (Al)	9200	mg/kg	0.1262	31.15	NA	
613SP019	Arsenic (As)	4	mg/kg	0.1828	45.15	10.4480	100.00
613SP019	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP019	Beryllium (Be)	ND	mg/kg	NA		NA	
613SP019	Chromium (Cr)	9.9	mg/kg	0.0272	6.70	NA	
613SP019	Manganese (Mn)	11.6	mg/kg	0.0034	0.84	NA	
613SP019	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP019	Vanadium (V)	33.4	mg/kg	0.0654	16.16	NA	
	Total			0.4049		10.4480	
613SP020	Aluminum (Al)	17200	mg/kg	0.2359	14.56	NA	
613SP020	Arsenic (As)	19.4	mg/kg	0.8867	54.75	50.6728	87.13
613SP020	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP020	Beryllium (Be)	1	mg/kg	0.0027	0.17	7.4877	12.87
613SP020	Chromium (Cr)	33.7	mg/kg	0.0924	5.71	NA	
613SP020	Manganese (Mn)	556	mg/kg	0.1622	10.01	NA	
613SP020	Thallium (Tl)	0.85	mg/kg	0.1457	9.00	NA	
613SP020	Vanadium (V)	48	mg/kg	0.0940	5.81	NA	
	Total			1.6197		58.1606	
613SP021	Aluminum (Al)	7210	mg/kg	0.0989	41.21	NA	

613SP021	Arsenic (As)	2	mg/kg	0.0914	38.10	5.2240	21.53
613SP021	B(a)P Equiv.	1086.4	ug/kg	NA		17.9911	74.15
613SP021	Beryllium (Be)	0.14	mg/kg	0.0004	0.16	1.0483	4.32
613SP021	Chromium (Cr)	8	mg/kg	0.0219	9.14	NA	
613SP021	Manganese (Mn)	12.4	mg/kg	0.0036	1.51	NA	
613SP021	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP021	Vanadium (V)	12.1	mg/kg	0.0237	9.88	NA	
	Total			0.2399		24.2634	
613SP022	Aluminum (Al)	10600	mg/kg	0.1454	20.74	NA	
613SP022	Arsenic (As)	6	mg/kg	0.2742	39.13	15.6720	60.15
613SP022	B(a)P Equiv.	305.93	ug/kg	NA		5.0663	19.44
613SP022	Beryllium (Be)	0.71	mg/kg	0.0019	0.28	5.3163	20.40
613SP022	Chromium (Cr)	16.2	mg/kg	0.0444	6.34	NA	
613SP022	Manganese (Mn)	77.9	mg/kg	0.0227	3.24	NA	
613SP022	Thallium (Tl)	0.93	mg/kg	0.1594	22.75	NA	
613SP022	Vanadium (V)	26.9	mg/kg	0.0527	7.52	NA	
	Total			0.7008		26.0546	
613SP023	Aluminum (Al)	5380	mg/kg	0.0738	28.38	NA	
613SP023	Arsenic (As)	2.8	mg/kg	0.1280	49.24	7.3136	100.00
613SP023	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP023	Beryllium (Be)	ND	mg/kg	NA		NA	
613SP023	Chromium (Cr)	7.7	mg/kg	0.0211	8.12	NA	
613SP023	Manganese (Mn)	12.8	mg/kg	0.0037	1.44	NA	
613SP023	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP023	Vanadium (V)	17	mg/kg	0.0333	12.81	NA	
	Total			0.2599		7.3136	
613SP024	Aluminum (Al)	17500	mg/kg	0.2400	8.37	NA	
613SP024	Arsenic (As)	44.8	mg/kg	2.0477	71.39	117.0176	91.57
613SP024	B(a)P Equiv.	108.23	ug/kg	NA		1.7923	1.40
613SP024	Beryllium (Be)	1.2	mg/kg	0.0033	0.11	8.9853	7.03
613SP024	Chromium (Cr)	35.6	mg/kg	0.0976	3.40	NA	
613SP024	Manganese (Mn)	755	mg/kg	0.2202	7.68	NA	
613SP024	Thallium (Tl)	0.7	mg/kg	0.1200	4.18	NA	
613SP024	Vanadium (V)	71.3	mg/kg	0.1397	4.87	NA	
	Total			2.8685		127.7953	
613SP025	Aluminum (Al)	7640	mg/kg	0.1048	29.75	NA	
613SP025	Arsenic (As)	2.3	mg/kg	0.1051	29.86	6.0076	85.14
613SP025	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP025	Beryllium (Be)	0.14	mg/kg	0.0004	0.11	1.0483	14.86
613SP025	Chromium (Cr)	8.6	mg/kg	0.0236	6.70	NA	
613SP025	Manganese (Mn)	15.2	mg/kg	0.0044	1.26	NA	
613SP025	Thallium (Tl)	0.52	mg/kg	0.0891	25.31	NA	
613SP025	Vanadium (V)	12.6	mg/kg	0.0247	7.01	NA	
	Total			0.3521		7.0559	
613SP026	Aluminum (Al)	9290	mg/kg	0.1274	19.28	NA	
613SP026	Arsenic (As)	8.5	mg/kg	0.3885	58.79	22.2020	83.17
613SP026	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP026	Beryllium (Be)	0.6	mg/kg	0.0016	0.25	4.4926	16.83
613SP026	Chromium (Cr)	16.6	mg/kg	0.0455	6.89	NA	
613SP026	Manganese (Mn)	137	mg/kg	0.0400	6.05	NA	
613SP026	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP026	Vanadium (V)	29.5	mg/kg	0.0578	8.74	NA	
	Total			0.6608		26.6947	
613SP027	Aluminum (Al)	8020	mg/kg	0.1100	26.98	NA	

613SP027	Arsenic (As)	4.5	mg/kg	0.2057	50.47	11.7540	100.00
613SP027	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP027	Beryllium (Be)	ND	mg/kg	NA		NA	
613SP027	Chromium (Cr)	12.5	mg/kg	0.0343	8.41	NA	
613SP027	Manganese (Mn)	12.1	mg/kg	0.0035	0.87	NA	
613SP027	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP027	Vanadium (V)	27.6	mg/kg	0.0541	13.27	NA	
	Total			0.4075		11.7540	
613SP028	Aluminum (Al)	11900	mg/kg	0.1632	18.51	NA	
613SP028	Arsenic (As)	11.6	mg/kg	0.5302	60.15	30.2992	84.19
613SP028	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP028	Beryllium (Be)	0.76	mg/kg	0.0021	0.24	5.6907	15.81
613SP028	Chromium (Cr)	22	mg/kg	0.0603	6.84	NA	
613SP028	Manganese (Mn)	149	mg/kg	0.0435	4.93	NA	
613SP028	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP028	Vanadium (V)	42	mg/kg	0.0823	9.33	NA	
	Total			0.8815		35.9899	
613SP029	Aluminum (Al)	7830	mg/kg	0.1074	30.86	NA	
613SP029	Arsenic (As)	2.2	mg/kg	0.1006	28.90	5.7464	35.75
613SP029	B(a)P Equiv.	564.78	ug/kg	NA		9.3529	58.19
613SP029	Beryllium (Be)	0.13	mg/kg	0.0004	0.10	0.9734	6.06
613SP029	Chromium (Cr)	9.4	mg/kg	0.0258	7.41	NA	
613SP029	Manganese (Mn)	16.8	mg/kg	0.0049	1.41	NA	
613SP029	Thallium (Tl)	0.47	mg/kg	0.0806	23.15	NA	
613SP029	Vanadium (V)	14.5	mg/kg	0.0284	8.16	NA	
	Total			0.3479		16.0727	
613SP030	Aluminum (Al)	18800	mg/kg	0.2578	27.64	NA	
613SP030	Arsenic (As)	10.2	mg/kg	0.4662	49.99	26.6424	83.56
613SP030	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP030	Beryllium (Be)	0.7	mg/kg	0.0019	0.21	5.2414	16.44
613SP030	Chromium (Cr)	31.3	mg/kg	0.0858	9.20	NA	
613SP030	Manganese (Mn)	73.9	mg/kg	0.0216	2.31	NA	
613SP030	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP030	Vanadium (V)	50.7	mg/kg	0.0993	10.65	NA	
	Total			0.9326		31.8838	
613SP031	Aluminum (Al)	11100	mg/kg	0.1522	21.35	NA	
613SP031	Arsenic (As)	8.5	mg/kg	0.3885	54.51	22.2020	85.00
613SP031	B(a)P Equiv.	5.98	ug/kg	NA		0.0990	0.38
613SP031	Beryllium (Be)	0.51	mg/kg	0.0014	0.20	3.8187	14.62
613SP031	Chromium (Cr)	20.9	mg/kg	0.0573	8.04	NA	
613SP031	Manganese (Mn)	142	mg/kg	0.0414	5.81	NA	
613SP031	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP031	Vanadium (V)	36.7	mg/kg	0.0719	10.09	NA	
	Total			0.7128		26.1198	
613SP032	Aluminum (Al)	11000	mg/kg	0.1508	31.38	NA	
613SP032	Arsenic (As)	4.2	mg/kg	0.1920	39.94	10.9704	76.45
613SP032	B(a)P Equiv.	82.033	ug/kg	NA		1.3585	9.47
613SP032	Beryllium (Be)	0.27	mg/kg	0.0007	0.15	2.0217	14.09
613SP032	Chromium (Cr)	23.9	mg/kg	0.0655	13.64	NA	
613SP032	Manganese (Mn)	19.7	mg/kg	0.0057	1.20	NA	
613SP032	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP032	Vanadium (V)	33.6	mg/kg	0.0658	13.69	NA	
	Total			0.4807		14.3506	
613SP033	Aluminum (Al)	7890	mg/kg	0.1082	44.97	NA	

613SP033	Arsenic (As)	1.8	mg/kg	0.0823	34.20	4.7016	85.09
613SP033	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP033	Beryllium (Be)	0.11	mg/kg	0.0003	0.13	0.8237	14.91
613SP033	Chromium (Cr)	7.7	mg/kg	0.0211	8.78	NA	
613SP033	Manganese (Mn)	8.4	mg/kg	0.0025	1.02	NA	
613SP033	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP033	Vanadium (V)	13.4	mg/kg	0.0262	10.91	NA	
	Total			0.2406		5.5253	
613SP034	Aluminum (Al)	11800	mg/kg	0.1618	24.26	NA	
613SP034	Arsenic (As)	7.6	mg/kg	0.3474	52.08	19.8512	84.36
613SP034	B(a)P Equiv.	86.571	ug/kg	NA		1.4336	6.09
613SP034	Beryllium (Be)	0.3	mg/kg	0.0008	0.12	2.2463	9.55
613SP034	Chromium (Cr)	23.8	mg/kg	0.0653	9.79	NA	
613SP034	Manganese (Mn)	26.5	mg/kg	0.0077	1.16	NA	
613SP034	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP034	Vanadium (V)	42.9	mg/kg	0.0840	12.60	NA	
	Total			0.6670		23.5312	
613SP035	Aluminum (Al)	8070	mg/kg	0.1107	22.23	NA	
613SP035	Arsenic (As)	6.3	mg/kg	0.2880	57.84	16.4556	92.36
613SP035	B(a)P Equiv.	82.16	ug/kg	NA		1.3606	7.64
613SP035	Beryllium (Be)	ND	mg/kg	NA		NA	
613SP035	Chromium (Cr)	13.3	mg/kg	0.0365	7.33	NA	
613SP035	Manganese (Mn)	45.4	mg/kg	0.0132	2.66	NA	
613SP035	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP035	Vanadium (V)	25.3	mg/kg	0.0496	9.95	NA	
	Total			0.4979		17.8162	
613SP036	Aluminum (Al)	12800	mg/kg	0.1755	20.63	NA	
613SP036	Arsenic (As)	6.8	mg/kg	0.3108	36.53	17.7616	87.79
613SP036	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP036	Beryllium (Be)	0.33	mg/kg	0.0009	0.11	2.4710	12.21
613SP036	Chromium (Cr)	25.2	mg/kg	0.0691	8.12	NA	
613SP036	Manganese (Mn)	21.7	mg/kg	0.0063	0.74	NA	
613SP036	Thallium (Tl)	1.2	mg/kg	0.2057	24.17	NA	
613SP036	Vanadium (V)	42.1	mg/kg	0.0825	9.69	NA	
	Total			0.8508		20.2326	
613SP037	Aluminum (Al)	11300	mg/kg	0.1549	24.59	NA	
613SP037	Arsenic (As)	5	mg/kg	0.2285	36.26	13.0600	87.03
613SP037	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP037	Beryllium (Be)	0.26	mg/kg	0.0007	0.11	1.9468	12.97
613SP037	Chromium (Cr)	20.7	mg/kg	0.0568	9.01	NA	
613SP037	Manganese (Mn)	24.9	mg/kg	0.0073	1.15	NA	
613SP037	Thallium (Tl)	0.76	mg/kg	0.1303	20.67	NA	
613SP037	Vanadium (V)	26.4	mg/kg	0.0517	8.21	NA	
	Total			0.6302		15.0068	
613SP038	Aluminum (Al)	7400	mg/kg	0.1015	40.44	NA	
613SP038	Arsenic (As)	2.1	mg/kg	0.0960	38.26	5.4852	84.93
613SP038	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP038	Beryllium (Be)	0.13	mg/kg	0.0004	0.14	0.9734	15.07
613SP038	Chromium (Cr)	8.1	mg/kg	0.0222	8.85	NA	
613SP038	Manganese (Mn)	8.5	mg/kg	0.0025	0.99	NA	
613SP038	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP038	Vanadium (V)	14.5	mg/kg	0.0284	11.32	NA	
	Total			0.2509		6.4586	
613SP039	Aluminum (Al)	3400	mg/kg	0.0466	39.12	NA	

613SP039	Arsenic (As)	1	mg/kg	0.0457	38.35	2.6120	74.40
613SP039	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP039	Beryllium (Be)	0.12	mg/kg	0.0003	0.28	0.8985	25.60
613SP039	Chromium (Cr)	4.5	mg/kg	0.0123	10.36	NA	
613SP039	Manganese (Mn)	13	mg/kg	0.0038	3.18	NA	
613SP039	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP039	Vanadium (V)	5.3	mg/kg	0.0104	8.71	NA	
	Total			0.1192		3.5105	
613SP040	Aluminum (Al)	14400	mg/kg	0.1975	29.99	NA	
613SP040	Arsenic (As)	6.3	mg/kg	0.2880	43.74	16.4556	76.37
613SP040	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP040	Beryllium (Be)	0.68	mg/kg	0.0019	0.28	5.0917	23.63
613SP040	Chromium (Cr)	22.3	mg/kg	0.0612	9.29	NA	
613SP040	Manganese (Mn)	131	mg/kg	0.0382	5.80	NA	
613SP040	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP040	Vanadium (V)	36.6	mg/kg	0.0717	10.89	NA	
	Total			0.6583		21.5473	
613SP041	Aluminum (Al)	4670	mg/kg	0.0640	25.67	NA	
613SP041	Arsenic (As)	3.2	mg/kg	0.1463	58.63	8.3584	82.92
613SP041	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP041	Beryllium (Be)	0.23	mg/kg	0.0006	0.25	1.7222	17.08
613SP041	Chromium (Cr)	6.1	mg/kg	0.0167	6.71	NA	
613SP041	Manganese (Mn)	17.7	mg/kg	0.0052	2.07	NA	
613SP041	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP041	Vanadium (V)	8.5	mg/kg	0.0167	6.67	NA	
	Total			0.2495		10.0806	
613SP042	Aluminum (Al)	8550	mg/kg	0.1172	18.50	NA	
613SP042	Arsenic (As)	5.6	mg/kg	0.2560	40.39	14.6272	88.65
613SP042	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP042	Beryllium (Be)	0.25	mg/kg	0.0007	0.11	1.8719	11.35
613SP042	Chromium (Cr)	17.5	mg/kg	0.0480	7.57	NA	
613SP042	Manganese (Mn)	194	mg/kg	0.0566	8.93	NA	
613SP042	Thallium (Tl)	0.62	mg/kg	0.1063	16.77	NA	
613SP042	Vanadium (V)	25	mg/kg	0.0490	7.73	NA	
	Total			0.6337		16.4991	
613SP043	Aluminum (Al)	6300	mg/kg	0.0864	25.44	NA	
613SP043	Arsenic (As)	2.4	mg/kg	0.1097	32.31	6.2688	82.30
613SP043	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP043	Beryllium (Be)	0.18	mg/kg	0.0005	0.15	1.3478	17.70
613SP043	Chromium (Cr)	10.5	mg/kg	0.0288	8.48	NA	
613SP043	Manganese (Mn)	22	mg/kg	0.0064	1.89	NA	
613SP043	Thallium (Tl)	0.48	mg/kg	0.0823	24.23	NA	
613SP043	Vanadium (V)	13	mg/kg	0.0255	7.50	NA	
	Total			0.3395		7.6166	
613SP044	Aluminum (Al)	11900	mg/kg	0.1632	10.91	NA	
613SP044	Arsenic (As)	18.9	mg/kg	0.8639	57.73	49.3668	86.82
613SP044	B(a)P Equiv.	59	ug/kg	NA		0.9771	1.72
613SP044	Beryllium (Be)	0.87	mg/kg	0.0024	0.16	6.5143	11.46
613SP044	Chromium (Cr)	21.9	mg/kg	0.0601	4.01	NA	
613SP044	Manganese (Mn)	221	mg/kg	0.0645	4.31	NA	
613SP044	Thallium (Tl)	1.5	mg/kg	0.2571	17.18	NA	
613SP044	Vanadium (V)	43.5	mg/kg	0.0852	5.69	NA	
	Total			1.4963		56.8582	
613SP045	Aluminum (Al)	13800	mg/kg	0.1892	20.38	NA	

613SP045	Arsenic (As)	11	mg/kg	0.5028	54.15	28.7320	79.99
613SP045	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP045	Beryllium (Be)	0.96	mg/kg	0.0026	0.28	7.1882	20.01
613SP045	Chromium (Cr)	29.9	mg/kg	0.0820	8.83	NA	
613SP045	Manganese (Mn)	291	mg/kg	0.0849	9.14	NA	
613SP045	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP045	Vanadium (V)	34.2	mg/kg	0.0670	7.22	NA	
	Total			0.9285		35.9202	
613SP046	Aluminum (Al)	9190	mg/kg	0.1260	18.29	NA	
613SP046	Arsenic (As)	9	mg/kg	0.4114	59.70	23.5080	85.09
613SP046	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP046	Beryllium (Be)	0.55	mg/kg	0.0015	0.22	4.1183	14.91
613SP046	Chromium (Cr)	18.5	mg/kg	0.0507	7.36	NA	
613SP046	Manganese (Mn)	165	mg/kg	0.0481	6.99	NA	
613SP046	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP046	Vanadium (V)	26.2	mg/kg	0.0513	7.45	NA	
	Total			0.6891		27.6263	
613SP047	Aluminum (Al)	10600	mg/kg	0.1454	22.25	NA	
613SP047	Arsenic (As)	7.8	mg/kg	0.3565	54.58	20.3736	82.92
613SP047	B(a)P Equiv.	50	ug/kg	NA		0.8280	3.37
613SP047	Beryllium (Be)	0.45	mg/kg	0.0012	0.19	3.3695	13.71
613SP047	Chromium (Cr)	20.2	mg/kg	0.0554	8.48	NA	
613SP047	Manganese (Mn)	124	mg/kg	0.0362	5.54	NA	
613SP047	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP047	Vanadium (V)	29.9	mg/kg	0.0586	8.97	NA	
	Total			0.6532		24.5711	
613SP048	Aluminum (Al)	5890	mg/kg	0.0808	57.27	NA	
613SP048	Arsenic (As)	0.71	mg/kg	0.0325	23.01	1.8545	63.89
613SP048	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP048	Beryllium (Be)	0.14	mg/kg	0.0004	0.27	1.0483	36.11
613SP048	Chromium (Cr)	6.5	mg/kg	0.0178	12.64	NA	
613SP048	Manganese (Mn)	7.4	mg/kg	0.0022	1.53	NA	
613SP048	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP048	Vanadium (V)	3.8	mg/kg	0.0074	5.28	NA	
	Total			0.1410		2.9028	
613SP049	Aluminum (Al)	4940	mg/kg	0.0677	15.08	NA	
613SP049	Arsenic (As)	3.5	mg/kg	0.1600	35.61	9.1420	84.15
613SP049	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP049	Beryllium (Be)	0.23	mg/kg	0.0006	0.14	1.7222	15.85
613SP049	Chromium (Cr)	13.4	mg/kg	0.0367	8.18	NA	
613SP049	Manganese (Mn)	38.2	mg/kg	0.0111	2.48	NA	
613SP049	Thallium (Tl)	0.87	mg/kg	0.1491	33.19	NA	
613SP049	Vanadium (V)	12.2	mg/kg	0.0239	5.32	NA	
	Total			0.4493		10.8642	
613SP050	Aluminum (Al)	14600	mg/kg	0.2002	13.57	NA	
613SP050	Arsenic (As)	17.4	mg/kg	0.7953	53.93	45.4488	83.33
613SP050	B(a)P Equiv.	97	ug/kg	NA		1.6064	2.95
613SP050	Beryllium (Be)	1	mg/kg	0.0027	0.19	7.4877	13.73
613SP050	Chromium (Cr)	26.9	mg/kg	0.0738	5.00	NA	
613SP050	Manganese (Mn)	215	mg/kg	0.0627	4.25	NA	
613SP050	Thallium (Tl)	1.4	mg/kg	0.2400	16.27	NA	
613SP050	Vanadium (V)	51.1	mg/kg	0.1001	6.79	NA	
	Total			1.4748		54.5429	
613SP051	Aluminum (Al)	4340	mg/kg	0.0595	11.66	NA	

613SP051	Arsenic (As)	6.1	mg/kg	0.2788	54.61	15.9332	34.13
613SP051	B(a)P Equiv.	1775.3	ug/kg	NA		29.3995	62.98
613SP051	Beryllium (Be)	0.18	mg/kg	0.0005	0.10	1.3478	2.89
613SP051	Chromium (Cr)	14.6	mg/kg	0.0400	7.84	NA	
613SP051	Manganese (Mn)	40.3	mg/kg	0.0118	2.30	NA	
613SP051	Thallium (Tl)	0.55	mg/kg	0.0943	18.46	NA	
613SP051	Vanadium (V)	13.1	mg/kg	0.0257	5.03	NA	
	Total			0.5106		46.6805	
613SP052	Aluminum (Al)	21000	mg/kg	0.2880	16.81	NA	
613SP052	Arsenic (As)	21.9	mg/kg	1.0010	58.42	57.2028	84.35
613SP052	B(a)P Equiv.	7.8	ug/kg	NA		0.1292	0.19
613SP052	Beryllium (Be)	1.4	mg/kg	0.0038	0.22	10.4828	15.46
613SP052	Chromium (Cr)	39.6	mg/kg	0.1086	6.34	NA	
613SP052	Manganese (Mn)	530	mg/kg	0.1546	9.02	NA	
613SP052	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP052	Vanadium (V)	80.4	mg/kg	0.1575	9.19	NA	
	Total			1.7135		67.8148	
613SP053	Aluminum (Al)	19500	mg/kg	0.2674	18.81	NA	
613SP053	Arsenic (As)	17.6	mg/kg	0.8045	56.59	45.9712	77.92
613SP053	B(a)P Equiv.	243.82	ug/kg	NA		4.0377	6.84
613SP053	Beryllium (Be)	1.2	mg/kg	0.0033	0.23	8.9853	15.23
613SP053	Chromium (Cr)	40	mg/kg	0.1097	7.72	NA	
613SP053	Manganese (Mn)	380	mg/kg	0.1109	7.80	NA	
613SP053	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP053	Vanadium (V)	64.2	mg/kg	0.1258	8.85	NA	
	Total			1.4215		58.9942	
613SP054	Aluminum (Al)	7870	mg/kg	0.1079	28.01	NA	
613SP054	Arsenic (As)	3.5	mg/kg	0.1600	41.53	9.1420	68.37
613SP054	B(a)P Equiv.	56.395	ug/kg	NA		0.9339	6.98
613SP054	Beryllium (Be)	0.44	mg/kg	0.0012	0.31	3.2946	24.64
613SP054	Chromium (Cr)	14.5	mg/kg	0.0398	10.32	NA	
613SP054	Manganese (Mn)	118	mg/kg	0.0344	8.94	NA	
613SP054	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP054	Vanadium (V)	21.4	mg/kg	0.0419	10.88	NA	
	Total			0.3852		13.3705	
613SP055	Aluminum (Al)	17100	mg/kg	0.2345	31.43	NA	
613SP055	Arsenic (As)	6.4	mg/kg	0.2925	39.21	16.7168	75.87
613SP055	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP055	Beryllium (Be)	0.71	mg/kg	0.0019	0.26	5.3163	24.13
613SP055	Chromium (Cr)	25.9	mg/kg	0.0710	9.52	NA	
613SP055	Manganese (Mn)	233	mg/kg	0.0680	9.11	NA	
613SP055	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP055	Vanadium (V)	39.9	mg/kg	0.0782	10.48	NA	
	Total			0.7461		22.0331	
613SP056	Aluminum (Al)	26700	mg/kg	0.3661	23.41	NA	
613SP056	Arsenic (As)	15.2	mg/kg	0.6948	44.43	39.7024	79.11
613SP056	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP056	Beryllium (Be)	1.4	mg/kg	0.0038	0.25	10.4828	20.89
613SP056	Chromium (Cr)	48.1	mg/kg	0.1319	8.44	NA	
613SP056	Manganese (Mn)	301	mg/kg	0.0878	5.62	NA	
613SP056	Thallium (Tl)	0.95	mg/kg	0.1628	10.41	NA	
613SP056	Vanadium (V)	59.4	mg/kg	0.1164	7.44	NA	
	Total			1.5636		50.1852	
613SP057	Aluminum (Al)	13100	mg/kg	0.1796	15.07	NA	

613SP057	Arsenic (As)	14.4	mg/kg	0.6582	55.21	37.6128	85.53
613SP057	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP057	Beryllium (Be)	0.85	mg/kg	0.0023	0.20	6.3646	14.47
613SP057	Chromium (Cr)	24	mg/kg	0.0658	5.52	NA	
613SP057	Manganese (Mn)	189	mg/kg	0.0551	4.62	NA	
613SP057	Thallium (Tl)	0.9	mg/kg	0.1543	12.94	NA	
613SP057	Vanadium (V)	39.2	mg/kg	0.0768	6.44	NA	
	Total			1.1922		43.9774	
613SP058	Aluminum (Al)	9310	mg/kg	0.1277	17.20	NA	
613SP058	Arsenic (As)	7.2	mg/kg	0.3291	44.33	18.8064	88.08
613SP058	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP058	Beryllium (Be)	0.34	mg/kg	0.0009	0.13	2.5458	11.92
613SP058	Chromium (Cr)	20.9	mg/kg	0.0573	7.72	NA	
613SP058	Manganese (Mn)	45.8	mg/kg	0.0134	1.80	NA	
613SP058	Thallium (Tl)	0.9	mg/kg	0.1543	20.78	NA	
613SP058	Vanadium (V)	30.5	mg/kg	0.0597	8.05	NA	
	Total			0.7424		21.3522	
613SP059	Aluminum (Al)	17000	mg/kg	0.2331	22.30	NA	
613SP059	Arsenic (As)	8.1	mg/kg	0.3702	35.41	21.1572	88.98
613SP059	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP059	Beryllium (Be)	0.35	mg/kg	0.0010	0.09	2.6207	11.02
613SP059	Chromium (Cr)	39.4	mg/kg	0.1081	10.34	NA	
613SP059	Manganese (Mn)	33.4	mg/kg	0.0097	0.93	NA	
613SP059	Thallium (Tl)	1.3	mg/kg	0.2228	21.31	NA	
613SP059	Vanadium (V)	51.3	mg/kg	0.1005	9.61	NA	
	Total			1.0454		23.7779	
613SP060	Aluminum (Al)	9840	mg/kg	0.1349	28.61	NA	
613SP060	Arsenic (As)	4.7	mg/kg	0.2148	45.56	12.2764	73.64
613SP060	B(a)P Equiv.	98	ug/kg	NA		1.6229	9.74
613SP060	Beryllium (Be)	0.37	mg/kg	0.0010	0.22	2.7705	16.62
613SP060	Chromium (Cr)	19.3	mg/kg	0.0529	11.22	NA	
613SP060	Manganese (Mn)	37.2	mg/kg	0.0109	2.30	NA	
613SP060	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP060	Vanadium (V)	29.1	mg/kg	0.0570	12.09	NA	
	Total			0.4716		16.6698	
613SP061	Aluminum (Al)	6060	mg/kg	0.0831	20.84	NA	
613SP061	Arsenic (As)	5	mg/kg	0.2285	57.32	13.0600	66.48
613SP061	B(a)P Equiv.	239.47	ug/kg	NA		3.9657	20.19
613SP061	Beryllium (Be)	0.35	mg/kg	0.0010	0.24	2.6207	13.34
613SP061	Chromium (Cr)	12	mg/kg	0.0329	8.25	NA	
613SP061	Manganese (Mn)	65.5	mg/kg	0.0191	4.79	NA	
613SP061	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP061	Vanadium (V)	17.4	mg/kg	0.0341	8.55	NA	
	Total			0.3987		19.6464	
613SP062	Aluminum (Al)	16900	mg/kg	0.2317	13.32	NA	
613SP062	Arsenic (As)	20.9	mg/kg	0.9553	54.93	54.5908	84.30
613SP062	B(a)P Equiv.	71.504	ug/kg	NA		1.1841	1.83
613SP062	Beryllium (Be)	1.2	mg/kg	0.0033	0.19	8.9853	13.87
613SP062	Chromium (Cr)	34.1	mg/kg	0.0935	5.38	NA	
613SP062	Manganese (Mn)	479	mg/kg	0.1397	8.03	NA	
613SP062	Thallium (Tl)	1.1	mg/kg	0.1885	10.84	NA	
613SP062	Vanadium (V)	64.9	mg/kg	0.1271	7.31	NA	
	Total			1.7392		64.7602	
613SP063	Aluminum (Al)	12200	mg/kg	0.1673	22.08	NA	

613SP063	Arsenic (As)	6.8	mg/kg	0.3108	41.03	17.7616	82.02
613SP063	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP063	Beryllium (Be)	0.52	mg/kg	0.0014	0.19	3.8936	17.98
613SP063	Chromium (Cr)	18.8	mg/kg	0.0516	6.81	NA	
613SP063	Manganese (Mn)	274	mg/kg	0.0799	10.55	NA	
613SP063	Thallium (Tl)	0.52	mg/kg	0.0891	11.77	NA	
613SP063	Vanadium (V)	29.3	mg/kg	0.0574	7.58	NA	
	Total			0.7575		21.6552	
613SP064	Aluminum (Al)	10900	mg/kg	0.1495	24.81	NA	
613SP064	Arsenic (As)	6.9	mg/kg	0.3154	52.34	18.0228	72.54
613SP064	B(a)P Equiv.	100	ug/kg	NA		1.6560	6.67
613SP064	Beryllium (Be)	0.69	mg/kg	0.0019	0.31	5.1665	20.79
613SP064	Chromium (Cr)	15.6	mg/kg	0.0428	7.10	NA	
613SP064	Manganese (Mn)	157	mg/kg	0.0458	7.60	NA	
613SP064	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP064	Vanadium (V)	24.1	mg/kg	0.0472	7.84	NA	
	Total			0.6025		24.8454	
613SP065	Aluminum (Al)	14550	mg/kg	0.1995	19.76	NA	
613SP065	Arsenic (As)	11	mg/kg	0.5028	49.79	28.7320	80.01
613SP065	B(a)P Equiv.	94.32	ug/kg	NA		1.5620	4.35
613SP065	Beryllium (Be)	0.75	mg/kg	0.0021	0.20	5.6158	15.64
613SP065	Chromium (Cr)	26.55	mg/kg	0.0728	7.21	NA	
613SP065	Manganese (Mn)	260	mg/kg	0.0758	7.51	NA	
613SP065	Thallium (Tl)	0.5	mg/kg	0.0857	8.49	NA	
613SP065	Vanadium (V)	36.25	mg/kg	0.0710	7.03	NA	
	Total			1.0097		35.9098	
613SP066	Aluminum (Al)	16250	mg/kg	0.2228	21.43	NA	
613SP066	Arsenic (As)	10.7	mg/kg	0.4891	47.03	27.9484	82.94
613SP066	B(a)P Equiv.	98.54	ug/kg	NA		1.6319	4.84
613SP066	Beryllium (Be)	0.55	mg/kg	0.0015	0.15	4.1183	12.22
613SP066	Chromium (Cr)	22.4	mg/kg	0.0614	5.91	NA	
613SP066	Manganese (Mn)	219.5	mg/kg	0.0640	6.16	NA	
613SP066	Thallium (Tl)	0.75	mg/kg	0.1286	12.36	NA	
613SP066	Vanadium (V)	37	mg/kg	0.0725	6.97	NA	
	Total			1.0399		33.6985	
613SP067	Aluminum (Al)	14850	mg/kg	0.2036	15.05	NA	
613SP067	Arsenic (As)	19	mg/kg	0.8684	64.20	49.6280	86.38
613SP067	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP067	Beryllium (Be)	1.045	mg/kg	0.0029	0.21	7.8247	13.62
613SP067	Chromium (Cr)	28.8	mg/kg	0.0790	5.84	NA	
613SP067	Manganese (Mn)	315.5	mg/kg	0.0920	6.80	NA	
613SP067	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP067	Vanadium (V)	54.5	mg/kg	0.1068	7.89	NA	
	Total			1.3527		57.4527	
613SP068	Aluminum (Al)	24350	mg/kg	0.3339	17.13	NA	
613SP068	Arsenic (As)	24.5	mg/kg	1.1198	57.46	63.9940	85.30
613SP068	B(a)P Equiv.	10.072	ug/kg	NA		0.1668	0.22
613SP068	Beryllium (Be)	1.45	mg/kg	0.0040	0.20	10.8572	14.47
613SP068	Chromium (Cr)	42.45	mg/kg	0.1164	5.97	NA	
613SP068	Manganese (Mn)	775.5	mg/kg	0.2262	11.61	NA	
613SP068	Thallium (Tl)	ND	mg/kg	NA		NA	
613SP068	Vanadium (V)	75.75	mg/kg	0.1484	7.61	NA	
	Total			1.9487		75.0180	

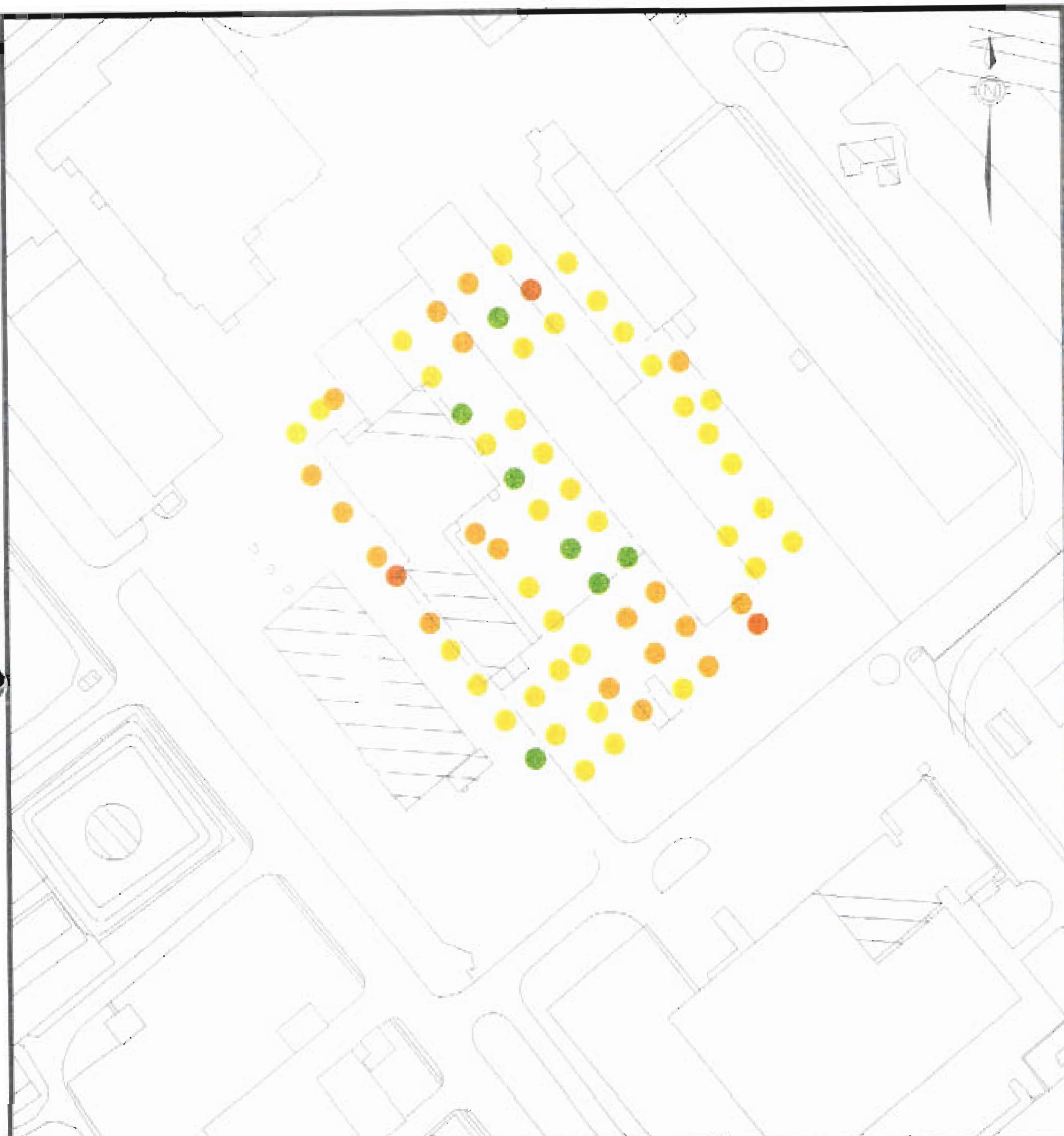
Soil - Site Worker Scenario

Industrial soil pathway COCs identified for combined AOC 613 were arsenic and BEQs. Figure 10.7-41 illustrates point risk estimates for combined AOC 613 based on soil exposure pathways under a future industrial scenario. Table 10.7.31 summarizes the risk and hazard contribution of each COC at each sample location. Arsenic was the primary contributor to risk estimates above 1E-06 for the industrial scenario, and BEQs were significant contributors at surface soil locations 613SP021, 613SP022, and 613SP051. Risk estimates ranged from 4E-07 (613SB048) to 2E-05 (613SB024). The mean risk estimate is 5E-06.

Hazard estimates ranged from 0.002 (613SB048) to 0.1 (613SB024).

Groundwater - Residential Scenario

Acenaphthene, aluminum, arsenic, benzene, beryllium, cadmium, chromium, 1,2-dichloroethene (total), bis(2-ethylhexyl)phthalate, fluorene, manganese, 2-methylnaphthalene, thallium, vanadium, phenanthrene, pyrene, PCE, toluene, and zinc were identified as groundwater pathway COCs. Figure 10.7-42 and 10.7-43 illustrates point risk and hazard estimates for combined AOC 613 based on groundwater exposure pathways under a future residential scenario. As shown in Table 10.7.32, arsenic was the most widespread contributor to risk estimates associated with the groundwater pathway, contributing to risk estimates above 1E-06 in 12 of 14 first quarter groundwater samples. Beryllium was the sole contributor to risk estimates associated with the groundwater sample collected from the deep well (61302D) and also contributed significantly to risk projections associated with groundwater samples collected from monitoring well 613001 and GEL008. Benzene and bis(2-ethylhexyl)phthalate were significant contributors to risk projections associated with the groundwater sample collected from monitoring well GEL014. Risk estimates ranged from 1E-02 (GEL014) to 5E-05 (GEL02D) with a mean risk of 1E-03.



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 300

ZONE F - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7.41
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
SWMU 175, AOC 613, 615

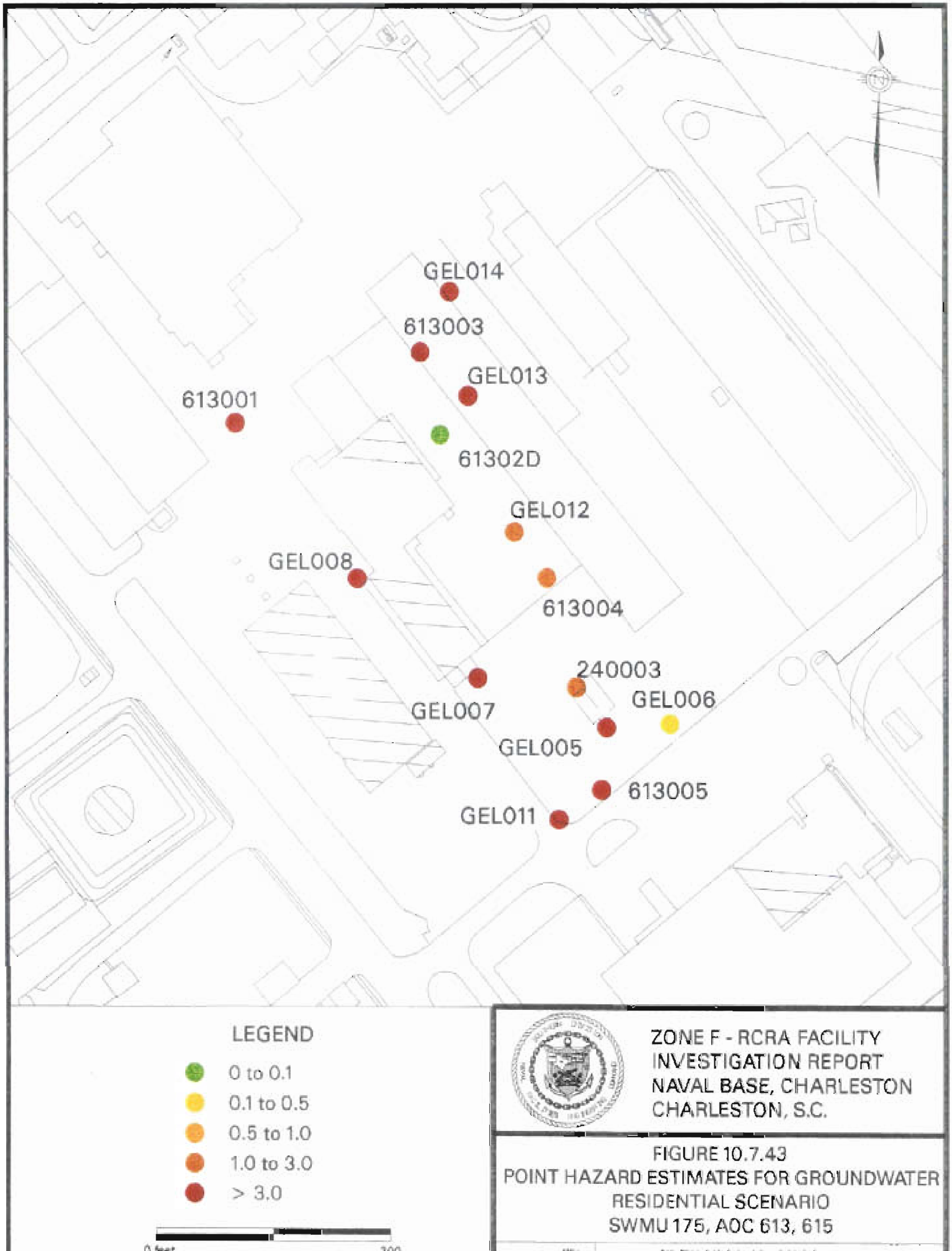


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FIGURE 10.7.43
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
SWMU 175, AOC 613, 615

Table 10.7.31
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 175 and AOCs 613 and 615
NAVBASE - Charleston
Charleston, South Carolina

Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
613SP001	Arsenic (As)	7.85	mg/kg	0.0180	99.63	2.9006	84.82
613SP001	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP001	Beryllium (Be)	0.49	mg/kg	0.00007	0.37	0.5190	15.18
	Total			0.0181		3.4197	
613SP002	Arsenic (As)	5.7	mg/kg	0.0131	99.40	2.1062	77.72
613SP002	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP002	Beryllium (Be)	0.57	mg/kg	0.00008	0.60	0.6038	22.28
	Total			0.0132		2.7100	
613SP003	Arsenic (As)	4.3	mg/kg	0.0099	99.03	1.5889	68.18
613SP003	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP003	Beryllium (Be)	0.7	mg/kg	0.00010	0.97	0.7415	31.82
	Total			0.0100		2.3304	
613SP004	Arsenic (As)	17.4	mg/kg	0.0400	99.49	6.4294	80.18
613SP004	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP004	Beryllium (Be)	1.5	mg/kg	0.00021	0.51	1.5889	19.82
	Total			0.0402		8.0183	
613SP005	Arsenic (As)	17.5	mg/kg	0.0402	99.56	6.4664	82.44
613SP005	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP005	Beryllium (Be)	1.3	mg/kg	0.00018	0.44	1.3770	17.56
	Total			0.0404		7.8434	
613SP006	Arsenic (As)	8.7	mg/kg	0.0200	99.55	3.2147	82.36
613SP006	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP006	Beryllium (Be)	0.65	mg/kg	0.00009	0.45	0.6885	17.64
	Total			0.0201		3.9032	
613SP007	Arsenic (As)	21.5	mg/kg	0.0494	99.53	7.9444	81.52
613SP007	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP007	Beryllium (Be)	1.7	mg/kg	0.00023	0.47	1.8007	18.48
	Total			0.0497		9.7451	
613SP008	Arsenic (As)	20.2	mg/kg	0.0464	99.56	7.4640	82.45
613SP008	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP008	Beryllium (Be)	1.5	mg/kg	0.00021	0.44	1.5889	17.55
	Total			0.0467		9.0529	
613SP009	Arsenic (As)	4	mg/kg	0.0092	99.72	1.4780	60.55
613SP009	B(a)P Equiv.	226.23	ug/kg	NA		0.7617	31.21
613SP009	Beryllium (Be)	0.19	mg/kg	0.00003	0.28	0.2013	8.24
	Total			0.0092		2.4410	
613SP010	Arsenic (As)	15.6	mg/kg	0.0359	99.64	5.7643	81.00
613SP010	B(a)P Equiv.	105.86	ug/kg	NA		0.3564	5.01
613SP010	Beryllium (Be)	0.94	mg/kg	0.00013	0.36	0.9957	13.99
	Total			0.0360		7.1165	
613SP012	Arsenic (As)	26.95	mg/kg	0.0620	99.68	9.9582	84.28

613SP012	B(a)P Equiv.	95.567	ug/kg	NA		0.3218	2.72
613SP012	Beryllium (Be)	1.45	mg/kg	0.00020	0.32	1.5359	13.00
	Total			0.0622		11.8159	
613SP013	Arsenic (As)	10.2	mg/kg	0.0235	99.61	3.7690	84.35
613SP013	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP013	Beryllium (Be)	0.66	mg/kg	0.00009	0.39	0.6991	15.65
	Total			0.0235		4.4681	
613SP014	Arsenic (As)	21.3	mg/kg	0.0490	99.61	7.8705	84.15
613SP014	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP014	Beryllium (Be)	1.4	mg/kg	0.00019	0.39	1.4830	15.85
	Total			0.0492		9.3535	
613SP017	Arsenic (As)	8.9	mg/kg	0.0205	99.76	3.2886	89.87
613SP017	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP017	Beryllium (Be)	0.35	mg/kg	0.00005	0.24	0.3707	10.13
	Total			0.0205		3.6594	
613SP018	Arsenic (As)	2.9	mg/kg	0.0067	100.00	1.0716	100.00
613SP018	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP018	Beryllium (Be)	ND	mg/kg	NA		NA	
	Total			0.0067		1.0716	
613SP019	Arsenic (As)	4	mg/kg	0.0092	100.00	1.4780	100.00
613SP019	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP019	Beryllium (Be)	ND	mg/kg	NA		NA	
	Total			0.0092		1.4780	
613SP020	Arsenic (As)	19.4	mg/kg	0.0446	99.69	7.1684	87.13
613SP020	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP020	Beryllium (Be)	1	mg/kg	0.00014	0.31	1.0593	12.87
	Total			0.0447		8.2277	
613SP021	Arsenic (As)	2	mg/kg	0.0046	99.58	0.7390	16.26
613SP021	B(a)P Equiv.	1086.4	ug/kg	NA		3.6581	80.48
613SP021	Beryllium (Be)	0.14	mg/kg	0.00002	0.42	0.1483	3.26
	Total			0.0046		4.5454	
613SP022	Arsenic (As)	6	mg/kg	0.0138	99.30	2.2170	55.44
613SP022	B(a)P Equiv.	305.93	ug/kg	NA		1.0301	25.76
613SP022	Beryllium (Be)	0.71	mg/kg	0.00010	0.70	0.7521	18.81
	Total			0.0139		3.9992	
613SP023	Arsenic (As)	2.8	mg/kg	0.0064	100.00	1.0346	100.00
613SP023	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP023	Beryllium (Be)	ND	mg/kg	NA		NA	
	Total			0.0064		1.0346	
613SP024	Arsenic (As)	44.8	mg/kg	0.1030	99.84	16.5539	91.01
613SP024	B(a)P Equiv.	108.23	ug/kg	NA		0.3644	2.00
613SP024	Beryllium (Be)	1.2	mg/kg	0.00017	0.16	1.2711	6.99
	Total			0.1032		18.1894	
613SP025	Arsenic (As)	2.3	mg/kg	0.0053	99.64	0.8499	85.14
613SP025	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP025	Beryllium (Be)	0.14	mg/kg	0.00002	0.36	0.1483	14.86
	Total			0.0053		0.9982	
613SP026	Arsenic (As)	8.5	mg/kg	0.0195	99.58	3.1408	83.17

613SP026	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP026	Beryllium (Be)	0.6	mg/kg	0.00008	0.42	0.6356	16.83
	Total			0.0196		3.7764	
613SP027	Arsenic (As)	4.5	mg/kg	0.0103	100.00	1.6628	100.00
613SP027	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP027	Beryllium (Be)	ND	mg/kg	NA		NA	
	Total			0.0103		1.6628	
613SP028	Arsenic (As)	11.6	mg/kg	0.0267	99.61	4.2863	84.19
613SP028	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP028	Beryllium (Be)	0.76	mg/kg	0.00010	0.39	0.8050	15.81
	Total			0.0268		5.0913	
613SP029	Arsenic (As)	2.2	mg/kg	0.0051	99.65	0.8129	28.50
613SP029	B(a)P Equiv.	564.78	ug/kg	NA		1.9017	66.67
613SP029	Beryllium (Be)	0.13	mg/kg	0.00002	0.35	0.1377	4.83
	Total			0.0051		2.8523	
613SP030	Arsenic (As)	10.2	mg/kg	0.0235	99.59	3.7690	83.56
613SP030	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP030	Beryllium (Be)	0.7	mg/kg	0.00010	0.41	0.7415	16.44
	Total			0.0235		4.5104	
613SP031	Arsenic (As)	8.5	mg/kg	0.0195	99.64	3.1408	84.86
613SP031	B(a)P Equiv.	5.98	ug/kg	NA		0.0201	0.54
613SP031	Beryllium (Be)	0.51	mg/kg	0.00007	0.36	0.5402	14.60
	Total			0.0196		3.7012	
613SP032	Arsenic (As)	4.2	mg/kg	0.0097	99.62	1.5519	73.41
613SP032	B(a)P Equiv.	82.033	ug/kg	NA		0.2762	13.07
613SP032	Beryllium (Be)	0.27	mg/kg	0.00004	0.38	0.2860	13.53
	Total			0.0097		2.1141	
613SP033	Arsenic (As)	1.8	mg/kg	0.0041	99.63	0.6651	85.09
613SP033	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP033	Beryllium (Be)	0.11	mg/kg	0.00002	0.37	0.1165	14.91
	Total			0.0042		0.7816	
613SP034	Arsenic (As)	7.6	mg/kg	0.0175	99.76	2.8083	82.17
613SP034	B(a)P Equiv.	86.571	ug/kg	NA		0.2915	8.53
613SP034	Beryllium (Be)	0.3	mg/kg	0.00004	0.24	0.3178	9.30
	Total			0.0175		3.4175	
613SP035	Arsenic (As)	6.3	mg/kg	0.0145	100.00	2.3279	89.38
613SP035	B(a)P Equiv.	82.16	ug/kg	NA		0.2766	10.62
613SP035	Beryllium (Be)	ND	mg/kg	NA		NA	
	Total			0.0145		2.6045	
613SP036	Arsenic (As)	6.8	mg/kg	0.0156	99.71	2.5126	87.79
613SP036	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP036	Beryllium (Be)	0.33	mg/kg	0.00005	0.29	0.3496	12.21
	Total			0.0157		2.8622	
613SP037	Arsenic (As)	5	mg/kg	0.0115	99.69	1.8475	87.03
613SP037	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP037	Beryllium (Be)	0.26	mg/kg	0.00004	0.31	0.2754	12.97
	Total			0.0115		2.1229	
613SP038	Arsenic (As)	2.1	mg/kg	0.0048	99.63	0.7760	84.93

613SP038	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP038	Beryllium (Be)	0.13	mg/kg	0.00002	0.37	0.1377	15.07
	Total			0.0048		0.9137	
613SP039	Arsenic (As)	1	mg/kg	0.0023	99.29	0.3695	74.40
613SP039	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP039	Beryllium (Be)	0.12	mg/kg	0.00002	0.71	0.1271	25.60
	Total			0.0023		0.4966	
613SP040	Arsenic (As)	6.3	mg/kg	0.0145	99.36	2.3279	76.37
613SP040	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP040	Beryllium (Be)	0.68	mg/kg	0.00009	0.64	0.7203	23.63
	Total			0.0146		3.0482	
613SP041	Arsenic (As)	3.2	mg/kg	0.0074	99.57	1.1824	82.92
613SP041	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP041	Beryllium (Be)	0.23	mg/kg	0.00003	0.43	0.2436	17.08
	Total			0.0074		1.4261	
613SP042	Arsenic (As)	5.6	mg/kg	0.0129	99.73	2.0692	88.65
613SP042	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP042	Beryllium (Be)	0.25	mg/kg	0.00003	0.27	0.2648	11.35
	Total			0.0129		2.3341	
613SP043	Arsenic (As)	2.4	mg/kg	0.0055	99.55	0.8868	82.30
613SP043	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP043	Beryllium (Be)	0.18	mg/kg	0.00002	0.45	0.1907	17.70
	Total			0.0055		1.0775	
613SP044	Arsenic (As)	18.9	mg/kg	0.0435	99.72	6.9837	86.18
613SP044	B(a)P Equiv.	59	ug/kg	NA		0.1987	2.45
613SP044	Beryllium (Be)	0.87	mg/kg	0.00012	0.28	0.9216	11.37
	Total			0.0436		8.1039	
613SP045	Arsenic (As)	11	mg/kg	0.0253	99.48	4.0646	79.99
613SP045	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP045	Beryllium (Be)	0.96	mg/kg	0.00013	0.52	1.0169	20.01
	Total			0.0254		5.0815	
613SP046	Arsenic (As)	9	mg/kg	0.0207	99.63	3.3256	85.09
613SP046	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP046	Beryllium (Be)	0.55	mg/kg	0.00008	0.37	0.5826	14.91
	Total			0.0208		3.9082	
613SP047	Arsenic (As)	7.8	mg/kg	0.0179	99.66	2.8822	81.71
613SP047	B(a)P Equiv.	50	ug/kg	NA		0.1684	4.77
613SP047	Beryllium (Be)	0.45	mg/kg	0.00006	0.34	0.4767	13.51
	Total			0.0180		3.5272	
613SP048	Arsenic (As)	0.71	mg/kg	0.0016	98.83	0.2623	63.89
613SP048	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP048	Beryllium (Be)	0.14	mg/kg	0.00002	1.17	0.1483	36.11
	Total			0.0017		0.4106	
613SP049	Arsenic (As)	3.5	mg/kg	0.0080	99.61	1.2933	84.15
613SP049	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP049	Beryllium (Be)	0.23	mg/kg	0.00003	0.39	0.2436	15.85
	Total			0.0081		1.5369	
613SP050	Arsenic (As)	17.4	mg/kg	0.0400	99.66	6.4294	82.27

613SP050	B(a)P Equiv.	97	ug/kg	NA		0.3266	4.18
613SP050	Beryllium (Be)	1	mg/kg	0.00014	0.34	1.0593	13.55
	Total			0.0401		7.8153	
613SP051	Arsenic (As)	6.1	mg/kg	0.0140	99.82	2.2540	26.76
613SP051	B(a)P Equiv.	1775.3	ug/kg	NA		5.9777	70.97
613SP051	Beryllium (Be)	0.18	mg/kg	0.00002	0.18	0.1907	2.26
	Total			0.0141		8.4223	
613SP052	Arsenic (As)	21.9	mg/kg	0.0504	99.62	8.0922	84.28
613SP052	B(a)P Equiv.	7.8	ug/kg	NA		0.0263	0.27
613SP052	Beryllium (Be)	1.4	mg/kg	0.00019	0.38	1.4830	15.45
	Total			0.0505		9.6014	
613SP053	Arsenic (As)	17.6	mg/kg	0.0405	80.06	6.5033	67.73
613SP053	B(a)P Equiv.	243.82	ug/kg	NA		0.8210	8.55
613SP053	Beryllium (Be)	1.2	mg/kg	0.00017	0.33	1.2711	13.24
	Total			0.0406		8.5954	
613SP054	Arsenic (As)	3.5	mg/kg	0.0080	99.25	1.2933	66.35
613SP054	B(a)P Equiv.	56.395	ug/kg	NA		0.1899	9.74
613SP054	Beryllium (Be)	0.44	mg/kg	0.00006	0.75	0.4661	23.91
	Total			0.0081		1.9492	
613SP055	Arsenic (As)	6.4	mg/kg	0.0147	99.34	2.3648	75.87
613SP055	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP055	Beryllium (Be)	0.71	mg/kg	0.00010	0.66	0.7521	24.13
	Total			0.0148		3.1169	
613SP056	Arsenic (As)	15.2	mg/kg	0.0349	99.45	5.6165	79.11
613SP056	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP056	Beryllium (Be)	1.4	mg/kg	0.00019	0.55	1.4830	20.89
	Total			0.0351		7.0995	
613SP057	Arsenic (As)	14.4	mg/kg	0.0331	99.65	5.3209	85.53
613SP057	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP057	Beryllium (Be)	0.85	mg/kg	0.00012	0.35	0.9004	14.47
	Total			0.0332		6.2213	
613SP058	Arsenic (As)	7.2	mg/kg	0.0166	99.72	2.6605	88.08
613SP058	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP058	Beryllium (Be)	0.34	mg/kg	0.00005	0.28	0.3601	11.92
	Total			0.0166		3.0206	
613SP059	Arsenic (As)	8.1	mg/kg	0.0186	99.74	2.9930	88.98
613SP059	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP059	Beryllium (Be)	0.35	mg/kg	0.00005	0.26	0.3707	11.02
	Total			0.0187		3.3637	
613SP060	Arsenic (As)	4.7	mg/kg	0.0108	99.53	1.7367	70.64
613SP060	B(a)P Equiv.	98	ug/kg	NA		0.3300	13.42
613SP060	Beryllium (Be)	0.37	mg/kg	0.00005	0.47	0.3919	15.94
	Total			0.0109		2.4586	
613SP061	Arsenic (As)	5	mg/kg	0.0115	99.58	1.8475	61.08
613SP061	B(a)P Equiv.	239.47	ug/kg	NA		0.8063	26.66
613SP061	Beryllium (Be)	0.35	mg/kg	0.00005	0.42	0.3707	12.26
	Total			0.0115		3.0246	
613SP062	Arsenic (As)	20.9	mg/kg	0.0481	99.66	7.7227	83.63

613SP062	B(a)P Equiv.	71.504	ug/kg	NA		0.2408	2.61
613SP062	Beryllium (Be)	1.2	mg/kg	0.00017	0.34	1.2711	13.76
	Total			0.0482		9.2346	
613SP063	Arsenic (As)	6.8	mg/kg	0.0156	99.54	2.5126	82.02
613SP063	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP063	Beryllium (Be)	0.52	mg/kg	0.00007	0.46	0.5508	17.98
	Total			0.0157		3.0635	
613SP064	Arsenic (As)	6.9	mg/kg	0.0159	99.40	2.5496	70.49
613SP064	B(a)P Equiv.	100	ug/kg	NA		0.3367	9.31
613SP064	Beryllium (Be)	0.69	mg/kg	0.00010	0.60	0.7309	20.21
	Total			0.0160		3.6172	
613SP065	Arsenic (As)	11	mg/kg	0.0253	99.59	4.0646	78.52
613SP065	B(a)P Equiv.	94.32	ug/kg	NA		0.3176	6.14
613SP065	Beryllium (Be)	0.75	mg/kg	0.00010	0.41	0.7944	15.35
	Total			0.0254		5.1766	
613SP066	Arsenic (As)	10.7	mg/kg	0.0246	99.69	3.9537	81.22
613SP066	B(a)P Equiv.	98.54	ug/kg	NA		0.3318	6.82
613SP066	Beryllium (Be)	0.55	mg/kg	0.00008	0.31	0.5826	11.97
	Total			0.0247		4.8681	
613SP067	Arsenic (As)	19	mg/kg	0.0437	99.67	7.0206	86.38
613SP067	B(a)P Equiv.	ND	ug/kg	NA		NA	
613SP067	Beryllium (Be)	1.045	mg/kg	0.00014	0.33	1.1069	13.62
	Total			0.0438		8.1276	
613SP068	Arsenic (As)	24.5	mg/kg	0.0563	99.65	9.0529	85.22
613SP068	B(a)P Equiv.	10.072	ug/kg	NA		0.0339	0.32
613SP068	Beryllium (Be)	1.45	mg/kg	0.00020	0.35	1.5359	14.46
	Total			0.0565		10.6228	

Table 10.7.32
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 175 and AOC 613 and 615
NAVBASE - Charleston
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
613	02D	Beryllium (Be)	0.77	UG/L	0.0098	100.00	49.2438	100.00
613	02D	Tetrachloroethene	ND	UG/L	NA		NA	
613	02D	Thallium (Tl)	ND	UG/L	NA		NA	
		Total			0.0098		49.2438	
240	003	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
240	003	2-Methylnaphthalene	ND	UG/L	NA		NA	
240	003	Acenaphthene	ND	UG/L	NA		NA	
240	003	Aluminum (Al)	803	UG/L	0.0513	2.32	NA	
240	003	Arsenic (As)	7.8	UG/L	1.6621	75.18	174.0117	100.00
240	003	Benzene	ND	UG/L	NA		NA	
240	003	Beryllium (Be)	ND	UG/L	NA		NA	
240	003	Cadmium (Cd)	ND	UG/L	NA		NA	
240	003	Chloromethane	ND	UG/L	NA		NA	
240	003	Chromium (Cr)	ND	UG/L	NA		NA	
240	003	Fluorene	ND	UG/L	NA		NA	
240	003	Lead (Pb)	ND	UG/L	NA		NA	
240	003	Manganese (Mn)	179	UG/L	0.4975	22.50	NA	
240	003	Phenanthrene	ND	UG/L	NA		NA	
240	003	Pyrene	ND	UG/L	NA		NA	
240	003	Tetrachloroethene	ND	UG/L	NA		NA	
240	003	Thallium (Tl)	ND	UG/L	NA		NA	
240	003	Toluene	ND	UG/L	NA		NA	
240	003	Trichloroethene	ND	UG/L	NA		NA	
240	003	Vanadium (V)	ND	UG/L	NA		NA	
240	003	Zinc (Zn)	ND	UG/L	NA		NA	
240	003	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			2.2110		174.0117	
613	001	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
613	001	2-Methylnaphthalene	ND	UG/L	NA		NA	
613	001	Acenaphthene	ND	UG/L	NA		NA	
613	001	Aluminum (Al)	3585	UG/L	0.2292	1.30	NA	
613	001	Arsenic (As)	2.5	UG/L	0.5327	3.02	55.7730	31.46
613	001	Benzene	ND	UG/L	NA		NA	
613	001	Beryllium (Be)	1.9	UG/L	0.0243	0.14	121.5108	68.54
613	001	Cadmium (Cd)	0.935	UG/L	0.1195	0.68	NA	
613	001	Chloromethane	ND	UG/L	NA		NA	
613	001	Chromium (Cr)	ND	UG/L	NA		NA	
613	001	Fluorene	ND	UG/L	NA		NA	
613	001	Lead (Pb)	2	UG/L	NA		NA	
613	001	Manganese (Mn)	6020	UG/L	16.7322	94.75	NA	
613	001	Phenanthrene	ND	UG/L	NA		NA	
613	001	Pyrene	ND	UG/L	NA		NA	
613	001	Tetrachloroethene	ND	UG/L	NA		NA	
613	001	Thallium (Tl)	ND	UG/L	NA		NA	
613	001	Toluene	ND	UG/L	NA		NA	
613	001	Trichloroethene	ND	UG/L	NA		NA	
613	001	Vanadium (V)	ND	UG/L	NA		NA	
613	001	Zinc (Zn)	102.5	UG/L	0.0218	0.12	NA	
613	001	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	

		Total			17.6598		177.2838	
613	003	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
613	003	2-Methylnaphthalene	ND	UG/L	NA		NA	
613	003	Acenaphthene	ND	UG/L	NA		NA	
613	003	Aluminum (Al)	472	UG/L	0.0302	0.24	NA	
613	003	Arsenic (As)	5.8	UG/L	1.2359	9.85	129.3933	100.00
613	003	Benzene	ND	UG/L	NA		NA	
613	003	Beryllium (Be)	ND	UG/L	NA		NA	
613	003	Cadmium (Cd)	ND	UG/L	NA		NA	
613	003	Chloromethane	ND	UG/L	NA		NA	
613	003	Chromium (Cr)	1.7	UG/L	0.0217	0.17	NA	
613	003	Fluorene	1	UG/L	0.0016	0.01	NA	
613	003	Lead (Pb)	ND	UG/L	NA		NA	
613	003	Manganese (Mn)	4050	UG/L	11.2567	89.72	NA	
613	003	Phenanthrene	ND	UG/L	NA		NA	
613	003	Pyrene	ND	UG/L	NA		NA	
613	003	Tetrachloroethene	ND	UG/L	NA		NA	
613	003	Thallium (Tl)	ND	UG/L	NA		NA	
613	003	Toluene	ND	UG/L	NA		NA	
613	003	Trichloroethene	ND	UG/L	NA		NA	
613	003	Vanadium (V)	ND	UG/L	NA		NA	
613	003	Zinc (Zn)	ND	UG/L	NA		NA	
613	003	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			12.5461		129.3933	
613	004	1,2-Dichloroethene (total)	24	UG/L	0.3409	12.58	NA	
613	004	2-Methylnaphthalene	ND	UG/L	NA		NA	
613	004	Acenaphthene	ND	UG/L	NA		NA	
613	004	Aluminum (Al)	3640	UG/L	0.2327	8.58	NA	
613	004	Arsenic (As)	3.3	UG/L	0.7032	25.94	73.6204	96.89
613	004	Benzene	ND	UG/L	NA		NA	
613	004	Beryllium (Be)	ND	UG/L	NA		NA	
613	004	Cadmium (Cd)	ND	UG/L	NA		NA	
613	004	Chloromethane	ND	UG/L	NA		NA	
613	004	Chromium (Cr)	6	UG/L	0.0767	2.83	NA	
613	004	Fluorene	ND	UG/L	NA		NA	
613	004	Lead (Pb)	3.5	UG/L	NA		NA	
613	004	Manganese (Mn)	428	UG/L	1.1896	43.88	NA	
613	004	Phenanthrene	ND	UG/L	NA		NA	
613	004	Pyrene	ND	UG/L	NA		NA	
613	004	Tetrachloroethene	2	UG/L	0.0256	0.94	1.6072	2.12
613	004	Thallium (Tl)	ND	UG/L	NA		NA	
613	004	Toluene	ND	UG/L	NA		NA	
613	004	Trichloroethene	3	UG/L	0.0639	2.36	0.7585	1.00
613	004	Vanadium (V)	8.2	UG/L	0.0749	2.76	NA	
613	004	Zinc (Zn)	16.9	UG/L	0.0036	0.13	NA	
613	004	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			2.7111		75.9860	
613	005	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
613	005	2-Methylnaphthalene	ND	UG/L	NA		NA	
613	005	Acenaphthene	ND	UG/L	NA		NA	
613	005	Aluminum (Al)	549	UG/L	0.0351	0.87	NA	
613	005	Arsenic (As)	9.9	UG/L	2.1096	52.34	220.8611	100.00
613	005	Benzene	ND	UG/L	NA		NA	
613	005	Beryllium (Be)	ND	UG/L	NA		NA	
613	005	Cadmium (Cd)	ND	UG/L	NA		NA	
613	005	Chloromethane	ND	UG/L	NA		NA	
613	005	Chromium (Cr)	1.4	UG/L	0.0179	0.44	NA	

613	005	Fluorene	ND	UG/L	NA		NA	
613	005	Lead (Pb)	ND	UG/L	NA		NA	
613	005	Manganese (Mn)	672	UG/L	1.8678	46.34	NA	
613	005	Phenanthrene	ND	UG/L	NA		NA	
613	005	Pyrene	ND	UG/L	NA		NA	
613	005	Tetrachloroethene	ND	UG/L	NA		NA	
613	005	Thallium (Tl)	ND	UG/L	NA		NA	
613	005	Toluene	ND	UG/L	NA		NA	
613	005	Trichloroethene	ND	UG/L	NA		NA	
613	005	Vanadium (V)	ND	UG/L	NA		NA	
613	005	Zinc (Zn)	ND	UG/L	NA		NA	
613	005	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			4.0304		220.8611	
GEL	005	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
GEL	005	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	005	Acenaphthene	ND	UG/L	NA		NA	
GEL	005	Aluminum (Al)	6500	UG/L	0.4155	6.43	NA	
GEL	005	Arsenic (As)	23.1	UG/L	4.9224	76.11	515.3425	100.00
GEL	005	Benzene	ND	UG/L	NA		NA	
GEL	005	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	005	Cadmium (Cd)	ND	UG/L	NA		NA	
GEL	005	Chloromethane	ND	UG/L	NA		NA	
GEL	005	Chromium (Cr)	11.9	UG/L	0.1521	2.35	NA	
GEL	005	Fluorene	ND	UG/L	NA		NA	
GEL	005	Lead (Pb)	8.8	UG/L	NA		NA	
GEL	005	Manganese (Mn)	274	UG/L	0.7616	11.78	NA	
GEL	005	Phenanthrene	ND	UG/L	NA		NA	
GEL	005	Pyrene	ND	UG/L	NA		NA	
GEL	005	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	005	Thallium (Tl)	ND	UG/L	NA		NA	
GEL	005	Toluene	ND	UG/L	NA		NA	
GEL	005	Trichloroethene	ND	UG/L	NA		NA	
GEL	005	Vanadium (V)	23.6	UG/L	0.2155	3.33	NA	
GEL	005	Zinc (Zn)	ND	UG/L	NA		NA	
GEL	005	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			6.4671		515.3425	
GEL	006	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
GEL	006	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	006	Acenaphthene	ND	UG/L	NA		NA	
GEL	006	Aluminum (Al)	831	UG/L	0.0531	24.55	NA	
GEL	006	Arsenic (As)	ND	UG/L	NA		NA	
GEL	006	Benzene	ND	UG/L	NA		NA	
GEL	006	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	006	Cadmium (Cd)	ND	UG/L	NA		NA	
GEL	006	Chloromethane	ND	UG/L	NA		NA	
GEL	006	Chromium (Cr)	ND	UG/L	NA		NA	
GEL	006	Fluorene	ND	UG/L	NA		NA	
GEL	006	Lead (Pb)	ND	UG/L	NA		NA	
GEL	006	Manganese (Mn)	51.2	UG/L	0.1423	65.75	NA	
GEL	006	Phenanthrene	ND	UG/L	NA		NA	
GEL	006	Pyrene	ND	UG/L	NA		NA	
GEL	006	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	006	Thallium (Tl)	ND	UG/L	NA		NA	
GEL	006	Toluene	ND	UG/L	NA		NA	
GEL	006	Trichloroethene	ND	UG/L	NA		NA	
GEL	006	Vanadium (V)	2	UG/L	0.0183	8.44	NA	
GEL	006	Zinc (Zn)	12.8	UG/L	0.0027	1.26	NA	
GEL	006	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	

		Total			0.2164		0.0000	
GEL	007	1,2-Dichloroethene (total)	3	UG/L	0.0426	0.20	NA	
GEL	007	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	007	Acenaphthene	ND	UG/L	NA		NA	
GEL	007	Aluminum (Al)	2590	UG/L	0.1656	0.77	NA	
GEL	007	Arsenic (As)	72	UG/L	15.3425	71.45	1606.2622	99.96
GEL	007	Benzene	ND	UG/L	NA		NA	
GEL	007	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	007	Cadmium (Cd)	ND	UG/L	NA		NA	
GEL	007	Chloromethane	2	UG/L	NA		0.5741	0.04
GEL	007	Chromium (Cr)	4.5	UG/L	0.0575	0.27	NA	
GEL	007	Fluorene	ND	UG/L	NA		NA	
GEL	007	Lead (Pb)	2.7	UG/L	NA		NA	
GEL	007	Manganese (Mn)	827	UG/L	2.2986	10.70	NA	
GEL	007	Phenanthrene	ND	UG/L	NA		NA	
GEL	007	Pyrene	ND	UG/L	NA		NA	
GEL	007	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	007	Thallium (Tl)	4.4	UG/L	3.5160	16.37	NA	
GEL	007	Toluene	ND	UG/L	NA		NA	
GEL	007	Trichloroethene	ND	UG/L	NA		NA	
GEL	007	Vanadium (V)	5.6	UG/L	0.0511	0.24	NA	
GEL	007	Zinc (Zn)	ND	UG/L	NA		NA	
GEL	007	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			21.4739		1606.8363	
GEL	008	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
GEL	008	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	008	Acenaphthene	ND	UG/L	NA		NA	
GEL	008	Aluminum (Al)	20000	UG/L	1.2785	7.02	NA	
GEL	008	Arsenic (As)	20.3	UG/L	4.3257	23.75	452.8767	79.73
GEL	008	Benzene	ND	UG/L	NA		NA	
GEL	008	Beryllium (Be)	1.8	UG/L	0.0230	0.13	115.1155	20.27
GEL	008	Cadmium (Cd)	ND	UG/L	NA		NA	
GEL	008	Chloromethane	ND	UG/L	NA		NA	
GEL	008	Chromium (Cr)	42.7	UG/L	0.5459	3.00	NA	
GEL	008	Fluorene	ND	UG/L	NA		NA	
GEL	008	Lead (Pb)	33.3	UG/L	NA		NA	
GEL	008	Manganese (Mn)	2120	UG/L	5.8924	32.35	NA	
GEL	008	Phenanthrene	ND	UG/L	NA		NA	
GEL	008	Pyrene	ND	UG/L	NA		NA	
GEL	008	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	008	Thallium (Tl)	6.9	UG/L	5.5137	30.27	NA	
GEL	008	Toluene	ND	UG/L	NA		NA	
GEL	008	Trichloroethene	ND	UG/L	NA		NA	
GEL	008	Vanadium (V)	68.3	UG/L	0.6237	3.42	NA	
GEL	008	Zinc (Zn)	65	UG/L	0.0139	0.08	NA	
GEL	008	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			18.2169		567.9922	
GEL	011	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
GEL	011	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	011	Acenaphthene	ND	UG/L	NA		NA	
GEL	011	Aluminum (Al)	17000	UG/L	1.0868	11.96	NA	
GEL	011	Arsenic (As)	14.3	UG/L	3.0472	33.53	319.0215	100.00
GEL	011	Benzene	ND	UG/L	NA		NA	
GEL	011	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	011	Cadmium (Cd)	2.7	UG/L	0.3452	3.80	NA	
GEL	011	Chloromethane	ND	UG/L	NA		NA	
GEL	011	Chromium (Cr)	32.3	UG/L	0.4130	4.54	NA	

GEL	011	Fluorene	ND	UG/L	NA		NA	
GEL	011	Lead (Pb)	30.8	UG/L	NA		NA	
GEL	011	Manganese (Mn)	1300	UG/L	3.6133	39.76	NA	
GEL	011	Phenanthrene	ND	UG/L	NA		NA	
GEL	011	Pyrene	ND	UG/L	NA		NA	
GEL	011	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	011	Thallium (Tl)	ND	UG/L	NA		NA	
GEL	011	Toluene	1	UG/L	0.0009	0.01	NA	
GEL	011	Trichloroethene	ND	UG/L	NA		NA	
GEL	011	Vanadium (V)	30	UG/L	0.2740	3.01	NA	
GEL	011	Zinc (Zn)	1440	UG/L	0.3068	3.38	NA	
GEL	011	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			9.0871		319.0215	
GEL	012	1,2-Dichloroethene (total)	2	UG/L	0.0284	2.21	NA	
GEL	012	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	012	Acenaphthene	ND	UG/L	NA		NA	
GEL	012	Aluminum (Al)	679	UG/L	0.0434	3.38	NA	
GEL	012	Arsenic (As)	2.95	UG/L	0.6286	48.88	65.8121	100.00
GEL	012	Benzene	ND	UG/L	NA		NA	
GEL	012	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	012	Cadmium (Cd)	ND	UG/L	NA		NA	
GEL	012	Chloromethane	ND	UG/L	NA		NA	
GEL	012	Chromium (Cr)	ND	UG/L	NA		NA	
GEL	012	Fluorene	ND	UG/L	NA		NA	
GEL	012	Lead (Pb)	ND	UG/L	NA		NA	
GEL	012	Manganese (Mn)	201.5	UG/L	0.5601	43.55	NA	
GEL	012	Phenanthrene	ND	UG/L	NA		NA	
GEL	012	Pyrene	ND	UG/L	NA		NA	
GEL	012	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	012	Thallium (Tl)	ND	UG/L	NA		NA	
GEL	012	Toluene	2	UG/L	0.0018	0.14	NA	
GEL	012	Trichloroethene	ND	UG/L	NA		NA	
GEL	012	Vanadium (V)	2.2	UG/L	0.0201	1.56	NA	
GEL	012	Zinc (Zn)	16.75	UG/L	0.0036	0.28	NA	
GEL	012	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	
		Total			1.2859		65.8121	
GEL	013	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
GEL	013	2-Methylnaphthalene	ND	UG/L	NA		NA	
GEL	013	Acenaphthene	ND	UG/L	NA		NA	
GEL	013	Aluminum (Al)	2190	UG/L	0.1400	2.49	NA	
GEL	013	Arsenic (As)	13.2	UG/L	2.8128	50.02	294.4814	100.00
GEL	013	Benzene	ND	UG/L	NA		NA	
GEL	013	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	013	Cadmium (Cd)	ND	UG/L	NA		NA	
GEL	013	Chloromethane	ND	UG/L	NA		NA	
GEL	013	Chromium (Cr)	ND	UG/L	NA		NA	
GEL	013	Fluorene	ND	UG/L	NA		NA	
GEL	013	Lead (Pb)	2.9	UG/L	NA		NA	
GEL	013	Manganese (Mn)	923	UG/L	2.5654	45.63	NA	
GEL	013	Phenanthrene	ND	UG/L	NA		NA	
GEL	013	Pyrene	ND	UG/L	NA		NA	
GEL	013	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	013	Thallium (Tl)	ND	UG/L	NA		NA	
GEL	013	Toluene	ND	UG/L	NA		NA	
GEL	013	Trichloroethene	ND	UG/L	NA		NA	
GEL	013	Vanadium (V)	11.1	UG/L	0.1014	1.80	NA	
GEL	013	Zinc (Zn)	15	UG/L	0.0032	0.06	NA	
GEL	013	bis(2-Ethylhexyl)phthalate (BEHP	ND	UG/L	NA		NA	

		Total			5.6228		294.4814	
GEL	014	1,2-Dichloroethene (total)	ND	UG/L	NA		NA	
GEL	014	2-Methylnaphthalene	2400000	UG/L	3835.6164	64.12	NA	
GEL	014	Acenaphthene	210000	UG/L	223.7443	3.74	NA	
GEL	014	Aluminum (Al)	0.91	UG/L	0.0001		NA	
GEL	014	Arsenic (As)	1.3	UG/L	0.2770		29.0020	0.25
GEL	014	Benzene	3800	UG/L	284.1197	4.75	3277.9648	28.17
GEL	014	Beryllium (Be)	ND	UG/L	NA		NA	
GEL	014	Cadmium (Cd)	0.3	UG/L	0.0384		NA	
GEL	014	Chloromethane	ND	UG/L	NA		NA	
GEL	014	Chromium (Cr)	0.27	UG/L	0.0035		NA	
GEL	014	Fluorene	340000	UG/L	543.3790	9.08	NA	
GEL	014	Lead (Pb)	4.6	UG/L	NA		NA	
GEL	014	Manganese (Mn)	0.07	UG/L	0.0002		NA	
GEL	014	Phenanthrene	570000	UG/L	910.9589	15.23	NA	
GEL	014	Pyrene	24000	UG/L	51.1416	0.85	NA	
GEL	014	Tetrachloroethene	ND	UG/L	NA		NA	
GEL	014	Thallium (Tl)	ND	UG/L	NA		NA	
GEL	014	Toluene	4900	UG/L	4.3139	0.07	NA	
GEL	014	Trichloroethene	ND	UG/L	NA		NA	
GEL	014	Vanadium (V)	5.2	UG/L	0.0475		NA	
GEL	014	Zinc (Zn)	7	UG/L	0.0015		NA	
GEL	014	bis(2-Ethylhexyl)phthalate (BEHP	40000	UG/L	127.8539	2.14	8328.7672	71.58
		Total			5981.4957		11635.7339	

Arsenic and manganese were the most significant contributors to hazard index projections at most locations. Aluminum, arsenic, cadmium, chromium, manganese, thallium, vanadium, and zinc were the most significant contributors to hazard index projections associated with monitoring well location GEL008 and GEL011. Acenaphthene, benzene, bis(2-ethylhexyl)phthalate, fluorene, 2-methylnaphthalene, phenanthrene, pyrene, and toluene were the most significant contributors to hazard index projections associated with monitoring well location GEL014. Hazard estimates ranged from 0.009 (61302D) to 5,981 (GEL014) with a mean hazard of 435.

The risk assessment and the point risk and hazard estimates for the groundwater pathways were based on first quarter sample results. The concentrations reported for petroluem-related chemicals and most of the inorganic parameters showed a significant drop in concentration between the first quarter sampling event and the second quarter sampling event. As a result, subsequent quarterly groundwater data should be review prior to any risk management decisions based on conclusions from the groundwater risk assessment.

10.7.7.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident or site worker as presented in Table 10.7.33 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.

Groundwater

Groundwater RGOs, based on the site resident scenario, are shown in Table 10.7.34.

Table 10.7.33
Remedial Goal Options for Soil
SWMU 175 and AOCs 613 and 615
Naval Base Charleston, Zone F
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Semivolatile Organics										
Benzo(a)pyrene equivalents	7.3	NA	0.8	ND	ND	ND	0.06	0.6	6	NA
Inorganics										
Aluminum (Al)	NA	1	14050	218781	72927	7293	ND	ND	ND	18500
Arsenic (As)	1.5	0.0003	13.1	66	22	2.2	0.38	3.8	38	19.9
Beryllium (Be)	4.3	0.005	0.84	1094	365	36	0.13	1.3	13	1.05

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Semivolatile Organics										
Benzo(a)pyrene equivalents	7.3	NA	0.8	ND	ND	ND	0.30	3.0	30	NA
Inorganics										
Arsenic (As)	1.5	0.0003	13.1	1305	435	43	2.7	27	271	19.9

NOTES:

EPC Exposure point concentration
NA Not applicable
- Remedial goal options were based on the residential or site worker lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.7.34
Residential-Based Remedial Goal Options Groundwater
SWMU 175 and AOCs 613 and 615
Naval Base Charleston Zone F
Charleston, South Carolina

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options **0.1** mg/l	**1.0** mg/l	**3** mg/l	Risk-Based Remedial Goal Options **1E-06** mg/l	**1E-05** mg/l	**1E-04** mg/l	MCL mg/l	Background Concentration mg/l
Inorganics											
Aluminum (Al)	NA	1	13.197	1.6	16	47	ND	ND	ND	NA	0.224
Arsenic (As)	1.5	0.0003	0.036	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.05	0.0167
Beryllium (Be)	4.3	0.005	0.0019	0.0078	0.078	0.23	0.000015	0.00015	0.0015	0.004	0.00066
Cadmium (Cd)	NA	0.0005	0.0027	0.00078	0.0078	0.023	ND	ND	ND	0.005	0.00082
Chromium (Cr)	NA	0.005	0.027	0.0078	0.078	0.23	ND	ND	ND	0.1	0.00205
Lead (Pb)	NA	NA	0.022	ND	ND	ND	ND	ND	ND	0.015	NA
Manganese (Mn)	NA	0.023	5.04	0.036	0.36	1.1	ND	ND	ND	NA	2.01
Thallium (Tl)	NA	8E-05	0.0045	0.00013	0.0013	0.0038	ND	ND	ND	0.002	0.00558
Vanadium (V)	NA	0.007	0.035	0.011	0.11	0.33	ND	ND	ND	NA	0.00158
Zinc (Zn)	NA	0.3	0.50	0.47	4.7	14	ND	ND	ND	NA	NA
Semivolatile Organics											
Acenaphthene	NA	0.06	210	0.094	0.94	2.8	ND	ND	ND	NA	NA
bis(2-Ethylhexyl)phthalate	0.014	0.02	40	0.031	0.31	0.94	0.0047	0.047	0.47	0.006	NA
Fluorene	NA	0.04	340	0.063	0.63	1.9	ND	ND	ND	NA	NA
2-Methylnaphthalene	NA	0.04	2400	0.063	0.63	1.9	ND	ND	ND	NA	NA
Phenanthrene	NA	0.04	570	0.063	0.63	1.9	ND	ND	ND	NA	NA
Pyrene	NA	0.03	24	0.047	0.47	1.4	ND	ND	ND	NA	NA
Volatile Organics											
Benzene	0.029	0.003	3.8	0.0017	0.017	0.051	0.0011	0.011	0.11	0.005	NA
1,2-Dichloroethene (total)	NA	0.009	0.024	0.0070	0.070	0.21	ND	ND	ND	0.07	NA
Tetrachloroethene	0.052	0.01	0.002	0.0078	0.078	0.23	0.0012	0.012	0.12	0.005	NA
Toluene	NA	0.2	4.9	0.11	1.1	3.4	ND	ND	ND	1	NA

NOTES:

EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

10.7.8 Corrective Measures Considerations

For AOCs 613/615 and SWMU 175, the upper and lower soil intervals and shallow and deep groundwater were investigated. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is covered with buildings or asphalt and concrete pavement.

BEQs, arsenic, and beryllium were identified as COCs in the upper soil interval. The soil pathway cumulative mean residential exposure risk is 7E-05 and the mean cumulative HI is 1.0 (resident child). Both of these are within USEPA's acceptable risk range between 1E-06 and 1E-04 and acceptable HI range between 1 and 0.1.

Residential risk-based remedial goals for surface soil for BEQs, arsenic, and beryllium are 0.06, 0.38, and 0.13 mg/kg respectively based on a target risk of 1E-06. Potential corrective measures, in addition to no further action for soil and respective COCs, are presented in Table 10.7.35.

Aluminum, arsenic, benzene, chlorobenzene, 2,4-dichloroethene, ethylbenzene, 2-methylphenol, 4-methylphenol, naphthalene, toluene, and xylene were identified in the shallow groundwater for AOC 613/615 and SWMU 175. Arsenic was the primary contributor to risk and hazard at all locations except for monitoring wells 61302D, 613001, and GEL014. The shallow groundwater pathway cumulative mean residential exposure risk is 5E-03 and the cumulative mean HI is 441 (resident child). The residential risk is above USEPA's acceptable risk of 1E-04.

Table 10.7.35
Potential Corrective Measures for AOC 613

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, beryllium, and benzo(a)pyrene equivalents	a) No Action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment f) Ex-situ, chemical and physical treatment
Shallow Groundwater	Aluminum, arsenic, benzene, chlorobenzene, 2,4-dichlorophenol, ethylbenzene, 2-methylphenol, 4-methylphenol, naphthalene, toluene, and xylene	a) No Action b) Intrinsic remediation and monitoring c) In-situ, chemical and physical treatment d) Ex-situ, chemical and physical treatment e) Free product recovery

The cumulative HI is above USEPA's acceptable HI of 1. The residential risk- and hazard-based RGOs for groundwater based on a target risk of 1E-06 and HI of 1 are shown on Table 10.7.31.

Potential corrective measures for the shallow groundwater and respective COCs are in Table 10.7.35. Corrective measures for AOC 613 are detailed in Section 9.

10.8 AOC 616, Paint Shop, Former Building 1201

A CSI site, AOC 616 is the former Building 1201, which operated as a paint shop from 1955 to 1977. The building has since been demolished and the site incorporated into a parking and storage lot for Building 69. Materials released, stored or disposed of at the site are paint thinner, solvents, and paint supply products.

10.8.1 Site Geology

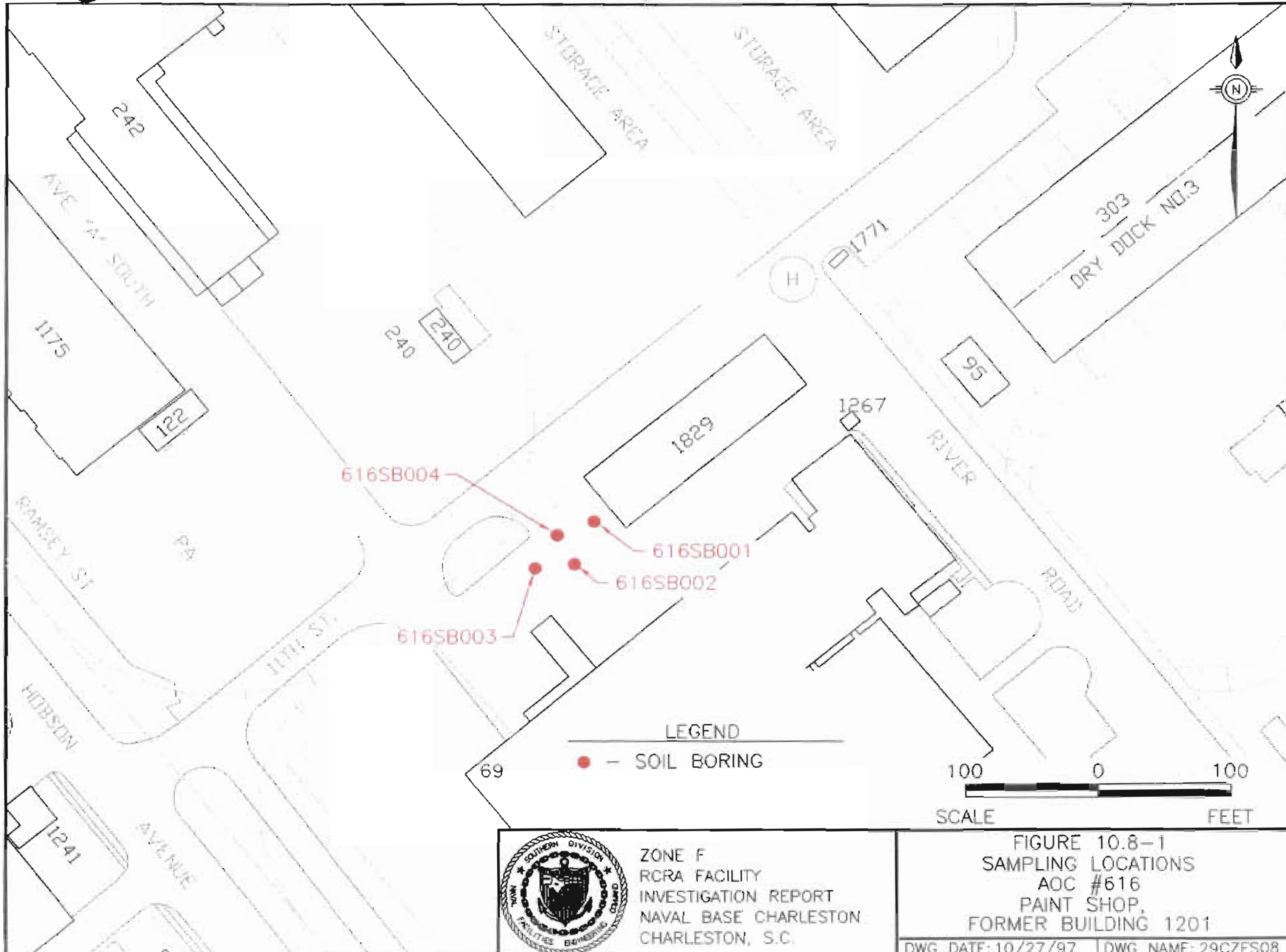
In accordance with the work plan, site stratigraphy was determined from adjacent AOC 617 borings which consisted of sandy clay overlying silty-clayey sand. Groundwater was encountered at approximately six ft bgs.

10.8.2 Field Investigation Approach

The field investigation at AOC 616 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Soil was the medium sampled during the field investigation. Section 3 of this report details the methods used during the field investigation. It describes the hand-auger procedures used to sample soil, other procedures, and analytical protocals. Figure 10.8-1 depicts the soil boring locations associated with the AOC 616 CSI. Appendix D contains the data report for Zone F samples.

10.8.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing four soil borings at AOC 616 to assess the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Four soil borings were advanced during the field investigation, as depicted in Figure 10.8-1. Upper and lower interval samples were collected from each location. In accordance with approved final RFI work plan, soil samples were analyzed for metals, SVOAs, and VOAs at DQO Level III. Table 10.8.1 summarizes the AOC 616 soil samples and analyses.



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.8–1
SAMPLING LOCATIONS
AOC #616
PAINT SHOP,
FORMER BUILDING 1201

DWG DATE: 10/27/97 | DWG NAME: 29CZFS08

Table 10.8.1
AOC 616
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
616SB001	616SB00101 616SB00102	Upper Lower	9/03/96	See Note	No deviations from work plan
616SB002	616SB00201 616SB00202	Upper Lower	9/03/96	See Note	
616SB003	616SB00301 616SB00302	Upper Lower	9/03/96	See Note	
616SB004	616SB00401 616SB00402	Upper Lower	9/04/96	See Note	

Note:
SW-846 (metals, SVOAs, and VOAs) at DQO Level III.

10.8.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.8.2. Inorganic analytical results for soil are summarized in Table 10.8.3. Table 10.8.4 summarizes all analytes detected in soil at AOC 616. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organic Compounds in Soil

No VOCs exceeded their RBCs in surface soil samples SSLs in AOC 616 subsurface soil.

Semivolatile Organic Compounds in Soil

Nineteen SVOCs were detected in surface and/or subsurface soil; however, no SVOCs exceeded RBCs or SSLs.

Table 10.8.2
AOC 616
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (μg/kg)						
2-Butanone	Upper	1/4	8.0	8.0	4700000	0
	Lower	2/4	3.0 - 5.0	4.0	7900	0
Benzene	Upper	0/4	ND	ND	22000	0
	Lower	1/4	2.0	2.0	30	0
Trichloroethene	Upper	0/4	ND	ND	58000	0
	Lower	1/4	2.0	2.0	60	0
Semivolatile Organic Compounds (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (μg/kg)						
BEQs[1]	Upper	1/4	4.255	4.255	88.0	0
	Lower	0/4	NA	NA	NA	NA
2-Methylnaphthalene	Upper	0/4	ND	ND	310000	0
	Lower	1/4	68.0	68.0	126000	0
Acenaphthene	Upper	0/4	ND	ND	470000	0
	Lower	1/4	570.0	570.0	570000[a]	0
Anthracene	Upper	0/4	ND	ND	2300000	0
	Lower	1/4	850.0	850.0	12000000[a]	0
Benzo(a)anthracene	Upper	0/4	ND	ND	880	0
	Lower	1/4	1300.0	1300.0	2000[b]	0
Benzo(a)pyrene	Upper	0/4	ND	ND	88	0
	Lower	1/4	1300.0	1300.0	8000	0

Table 10.8.2
AOC 616
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (μg/kg)						
Benzo(b)fluoranthene	Upper	1/4	42.0	42.0	880	0
	Lower	1/4	790.0	790.0	5000[b]	0
Benzo(g,h,i)perylene	Upper	0/4	ND	ND	230000	0
	Lower	1/4	730.0	730.0	4.66E+08	0
Benzo(k)fluoranthene	Upper	0/4	ND	ND	8800	0
	Lower	1/4	1000.0	1000.0	49000[b]	0
Benzoic acid	Upper	1/4	44.0	44.0	31000000	0
	Lower	1/4	41.0	41.0	400000[a,c]	0
Chrysene	Upper	1/4	55.0	55.0	88000	0
	Lower	1/4	1300.0	1300.0	160000[b]	0
Dibenz(a,h)anthracene	Upper	0/4	ND	ND	88	0
	Lower	1/4	220.0	220.0	2000[b]	0
Dibenzofuran	Upper	0/4	ND	ND	31000	0
	Lower	1/4	180.0	180.0	240000	0
Fluoranthene	Upper	1/4	62.0	62.0	310000	0
	Lower	1/4	3600.0	3600.0	4300000[a]	0
Fluorene	Upper	0/4	ND	ND	310000	0
	Lower	1/4	400.0	400.0	560000[a]	0
Indeno(1,2,3-cd)pyrene	Upper	0/4	ND	ND	880	0
	Lower	1/4	630.0	630.0	14000[b]	0

Table 10.8.2
AOC 616
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (μg/kg)						
Naphthalene	**Upper**	**0/4**	**ND**	**ND**	**310000**	**0**
	Lower	**1/4**	**70.0**	**70.0**	**84000[a]**	**0**
Phenanthrene	Upper	1/4	57.0	57.0	230000	0
	Lower	1/4	3400.0	3400.0	1380000	0
Pyrene	**Upper**	**1/4**	**70.0**	**70.0**	**230000**	**0**
	Lower	**1/4**	**3700.0**	**3700.0**	**4200000[a]**	**0**
bis(2-ethylhexyl)phthalate (BEHP)	Upper	1/4	98.0	98.0	46000	0
	Lower	0/4	ND	ND	3600000	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b).
a	=	Calculated values correspond to a noncancer hazard quotient of 1.
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c	=	SSL for pH of 6.8.
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
ND	=	Not detected
NA	=	Not applicable BEQs apply only to surface soils.
μg/kg	=	Micrograms per kilogram

Table 10.8.3
AOC 616
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (mg/kg)						
Aluminum	**Upper**	**4/4**	**3580.0 - 14400.0**	**6550.0**	**7800**	**1**
	Lower	**4/4**	**5300.0 - 11400.0**	**8540.0**	**1000000**	**0**
Antimony	Upper	1/4	3.1	3.1	3.1	1
	Lower	0/4	ND	ND	5	0
Arsenic	**Upper**	**4/4**	**0.86 - 12.4**	**4.24**	**0.43**	**4**
	Lower	**4/4**	**3.5 - 6.8**	**5.43**	**29[b]**	**0**
Barium	Upper	4/4	3.5 - 34.2	12.35	550	0
	Lower	4/4	11.9 - 16.9	14.78	1600[b]	0
Beryllium	**Upper**	**4/4**	**0.12 - 0.75**	**0.30**	**0.15**	**2**
	Lower	**4/4**	**0.18 - 0.32**	**0.28**	**63[b]**	**0**
Cadmium	Upper	4/4	0.07 - 1.80	0.53	3.9	0
	Lower	4/4	0.05 - 0.12	0.08	8[b]	0
Calcium	**Upper**	**4/4**	**744.0 - 55000.0**	**18248.5**	**NL**	**NA**
	Lower	**4/4**	**1010.0 - 3380.0**	**2157.5**	**NL**	**NA**
Chromium	Upper	4/4	4.4 - 34.0	12.53	39	0
	Lower	4/4	10.1 - 25.8	15.13	38[b]	0
Cobalt	**Upper**	**3/4**	**0.79 - 6.10**	**2.58**	**470**	**0**
	Lower	**4/4**	**0.87 - 1.60**	**1.17**	**2000**	**0**
Copper	Upper	1/4	65.4	65.4	310	0
	Lower	1/4	6.2	6.2	920	0

Table 10.8.3
AOC 616
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.[*] (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (mg/kg)						
Iron	Upper	4/4	1210.0 - 17900.0	6012.5	2300	2
	Lower	4/4	6600.0 - 21100.0	12717.5	NL	NA
Lead	**Upper**	**2/4**	**5.2 - 96.4**	**50.8**	**400[c]**	**0**
	Lower	**4/4**	**8.0 - 17.3**	**12.1**	**400[c]**	**0**
Magnesium	Upper	4/4	211.0 - 2470.0	878.5	NL	NA
	Lower	4/4	404.0 - 1390.0	814.75	NL	NA
Manganese	**Upper**	**4/4**	**5.7 - 168.0**	**50.75**	**180**	**0**
	Lower	**4/4**	**20.6 - 73.9**	**38.35**	**1100**	**0**
Mercury	Upper	1/4	0.37	0.37	2.3	0
	Lower	2/4	0.04 - 0.1	0.07	2.0[b]	0
Nickel	**Upper**	**4/4**	**1.1 - 20.0**	**6.08**	**160**	**0**
	Lower	**4/4**	**1.6 - 3.8**	**2.5**	**130[b]**	**0**
Potassium	Upper	4/4	155.0 - 1140.0	409.25	NL	NA
	Lower	4/4	347.0 - 816.0	494.0	NL	NA
Selenium	**Upper**	**3/4**	**0.57 - 1.10**	**0.82**	**39**	**0**
	Lower	**4/4**	**0.80 - 1.50**	**1.08**	**5[b]**	**0**
Sodium	Upper	4/4	150.0 - 386.0	227	NL	NA
	Lower	4/4	217.0 - 559.0	383.75	NL	NA
Vanadium	**Upper**	**4/4**	**3.9 - 35.0**	**12.98**	**55**	**0**
	Lower	**4/4**	**16.1 - 42.0**	**25.4**	**6000[a]**	**0**

Table 10.8.3
AOC 616
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 4 Samples/Lower Interval - 4 Samples) (mg/kg)						
Zinc	Upper	3/4	12.5 - 1800.0	664.83	2300	0
	Lower	4/4	9.0 - 28.1	16.73	12000[a,b]	0

Notes:

[a] = Calculated values correspond to a noncancer hazard quotient of 1.
[b] = SSL for pH of 6.8
[c] = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a).
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.8.4
AOC 616
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
2-Butanone	616SB003	ND	4700000	NA	3.0	7900	NA
	616SB004	8.0			5.0		
Benzene	616SB004	ND	22000	NA	2.0	30	NA
Trichloroethene	616SB004	ND	58000	NA	2.0	60	NA
Semivolatile Organic Compounds (μg/kg)							
BEQs[1]	616SB002	4.255	88.0	NA	NA	NA	NA
2-Methylnaphthalene	616SB002	ND	310000	NA	68.0	126000	NA
Acenaphthene	616SB002	ND	470000	NA	570.0	570000[a]	NA
Anthracene	616SB002	ND	2300000	NA	850.0	12000000[a]	NA
Benzo(a)anthracene	616SB002	ND	880.0	NA	1300.0	2000[b]	NA
Benzo(a)pyrene	616SB002	ND	88.0	NA	1300.0	8000	NA
Benzo(b)fluoranthene	616SB002	42.0	880.0	NA	790.0	5000[b]	NA
Benzo(g,h,i)perylene	616SB002	ND	230000.0	NA	730.0	4.66E+08	NA
Benzo(k)fluoranthene	616SB002	ND	8800.0	NA	1000.0	49000[b]	NA
Benzoic acid	616SB002	44.0	31000000	NA	41.0	400000[a,c]	NA
Chrysene	616SB002	55.0	88000.0	NA	1300.0	160000[b]	NA

Table 10.8.4
AOC 616
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg)							
Dibenz(a,h)anthracene	616SB002	ND	88	NA	220.0	2000[b]	NA
Dibenzofuran	616SB002	ND	31000	NA	180.0	240000	NA
Fluoranthene	616SB002	62.0	310000.0	NA	3600.0	4300000[a]	NA
Fluorene	616SB002	ND	310000	NA	400.0	560000[a]	NA
Indeno(1,2,3-cd)pyrene	616SB002	ND	880	NA	630.0	14000[b]	NA
Naphthalene	616SB002	ND	310000	NA	70.0	84000[a]	NA
Phenanthrene	616SB002	57.0	230000.0	NA	3400.0	1380000	NA
Pyrene	616SB002	70.0	230000.0	NA	3700.0	4200000[a]	NA
bis(2-Ethylhexyl)phthalate (BEHP)	616SB002	98.0	46000	NA	ND	3600000	NA
Inorganics (mg/kg)							
Aluminum (Al)	616SB001 616SB002 616SB003 616SB004	3580.0 14400.0 4380.0 3860.0	7800.0	18500	10700.0 11400.0 5300.0 6760.0	1000000	17100
Antimony (Sb)	616SB002	3.1	3.1	0.79	ND	5	ND

Table 10.8.4
AOC 616
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Arsenic (As)	**616SB001**	**0.86**	**0.43**	**19.9**	**6.80**	**29**[c]	**18.2**
	616SB002	**12.40**			**5.60**		
	616SB003	**2.00**			**3.50**		
	616SB004	**1.70**			**5.80**		
Barium (Ba)	616SB001	3.5	550.0	61.5	14.9	1600[c]	51.8
	616SB002	34.2			15.4		
	616SB003	6.7			11.9		
	616SB004	5.0			16.9		
Beryllium (Be)	**616SB001**	**0.12**	**0.15**	**1.05**	**0.32**	**63**[c]	**1.20**
	616SB002	**0.75**			**0.18**		
	616SB003	**0.19**			**0.29**		
	616SB004	**0.12**			**0.32**		
Cadmium (Cd)	616SB001	0.11	3.9	0.26	0.07	8[c]	0.09
	616SB002	1.80			0.12		
	616SB003	0.07			0.05		
	616SB004	0.13			0.08		
Calcium (Ca)	**616SB001**	**744.00**	**NL**	**NL**	**2550.0**	**NL**	**NL**
	616SB002	**55000.0**			**1010.0**		
	616SB003	**2350.00**			**1690.0**		
	616SB004	**14900.0**			**3380.0**		

Table 10.8.4
AOC 616
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Chromium (Cr)	**616SB001**	4.4	**39 VI**	**34.8**	**25.8**	**38[c] (total)**	**32.2**
			7800 III				
	616SB002	**34.0**			**13.4**		
	616SB003	**6.5**			**10.1**		
	616SB004	**5.2**			**11.2**		
Cobalt (Co)	616SB001	0.79	470.0	15.1	1.3	2000	6.85
	616SB002	6.10			0.87		
	616SB003	ND			0.92		
	616SB004	0.85			1.60		
Copper (Cu)	**616SB002**	**65.4**	**310.0**	**48.2**	**ND**	**920**	**30.4**
	616SB004	**ND**			**6.2**		
Iron (Fe)	616SB001	1210.0	2300.0	NL	21100.0	NL	NL
	616SB002	**17900.0**			13900.0		
	616SB003	**2830.0**			6600.00		
	616SB004	2110.0			9270.0		
Lead (Pb)	**616SB001**	**ND**	**400.0[d]**	**180**	**8.0**	**400[d]**	**51.7**
	616SB002	**96.4**			**8.5**		
	616SB003	**ND**			**14.6**		
	616SB004	**5.2**			**17.3**		
Magnesium (Mg)	616SB001	211.0	NL	NL	1390.0	NL	NL
	616SB002	2470.0			404.0		
	616SB003	339.0			605.0		
	616SB004	494.0			860.0		

Table 10.8.4
AOC 616
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Manganese (Mn)	**616SB001**	**5.7**	**180.0**	**307**	**35.0**	**1100**	**469**
	616SB002	**168.0**			**20.6**		
	616SB003	**9.9**			**23.9**		
	616SB004	**19.4**			**73.9**		
Mercury (Hg)	616SB002	0.37	2.3	0.62	0.04	2.0[c]	0.23
	616SB004	ND			0.10		
Nickel (Ni)	**616SB001**	**1.3**	**160.0**	**12.6**	**2.4**	**130[c]**	**8.85**
	616SB002	**20.0**			**2.2**		
	616SB003	**1.1**			**1.6**		
	616SB004	**1.9**			**3.8**		
Potassium (K)	616SB001	155.0	NL	NL	816.0	NL	NL
	616SB002	1140.0			347.0		
	616SB003	170.0			379.0		
	616SB004	172.0			434.0		
Selenium (Se)	**616SB001**	**ND**	**39.0**	**1.15**	**1.50**	**5[c]**	**1.24**
	616SB002	**1.10**			**1.20**		
	616SB003	**0.78**			**0.81**		
	616SB004	**0.57**			**0.80**		
Sodium (Na)	616SB001	150.0	NL	NL	559.0	NL	NL
	616SB002	386.0			242.0		
	616SB003	220.0			517.0		
	616SB004	152.0			217.0		

Table 10.8.4
AOC 616
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Vanadium (V)	616SB001	3.9	55.0	48.9	42.0	6000[a]	49.4
	616SB002	35.0			23.6		
	616SB003	7.9			16.1		
	616SB004	5.1			19.9		
Zinc (Zn)	616SB001	ND	2300.0	198	15.0	12000[a,c]	84.2
	616SB002	1800.0			14.8		
	616SB003	12.5			9.0		
	616SB004	182.0			28.1		

Notes:
a = Calculated values correspond to a noncancer hazard quotient of 1.
b = Calculated values correspond to a cancer risk level of 1 in 1,000,000.
c = SSL for pH of 6.8.
d = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (USEPA 1994a)*.
I = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2.
NA = Not available
ND = Not detected
NL = Not listed
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples.
mg/kg = Milligrams per kilogram
μg/kg = Microgram per kilogram
Bolded concentrations are equal to or exceed both the reference concentration (RBC or SSL) and the zone background.
All background reference values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

Inorganic Elements in Soil

Twenty-one metals were detected in AOC 616 soil samples. Antimony exceeded its Zone F background and equaled the RBC in surface soil. Iron exceeded its surface soil RBC at two locations; however, no background concentration for iron in surface soil was calculated because it is an essential nutrient. Figure 10.8-2 presents the antimony concentrations detected in surface soil samples.

No metals in subsurface soil exceeded SSLs and background concentrations for Zone F subsurface soil.

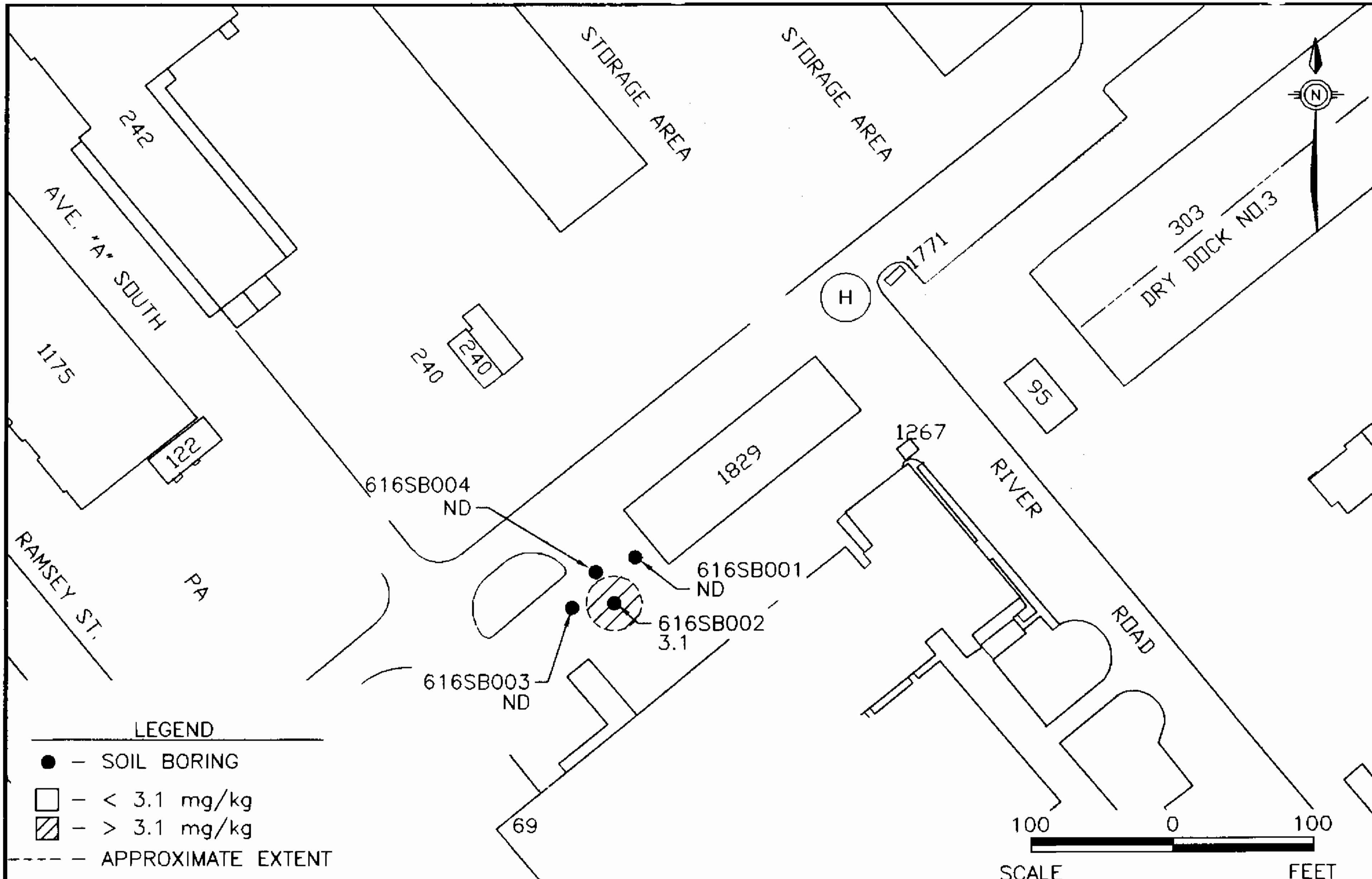
10.8.4 Fate and Transport Assessment for AOC 616

Samples collected as part of the AOC 616 investigation were obtained from surface and subsurface soil. The potential constituent migration pathways investigated for AOC 616 are soil-to-groundwater and soil-to-air.

10.8.4.1 AOC 616 — Soil-to-Groundwater Cross-Media Transport

Table 10.8.5 compares maximum detected organic concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater and background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

No constituents in AOC 616 surface or subsurface soil exceeded groundwater protection SSLs. As a result, the soil-to-groundwater migration pathway is not expected to be significant at AOC 616.



NOTES:
- 3.1 mg/kg = RBC FOR ANTIMONY IN SURFACE SOIL (USEPA 1996c)
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.8-2
ANTIMONY IN SURFACE SOIL
AOC #616
PAINT SHOP,
FORMER BUILDING 1201

DWG DATE: 12/01/97 | DWG NAME: 2906A616

Table 10.8.5
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 616
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Benzene	ND	2	NA	NA	30	0.36	109	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	8	5	NA	NA	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Trichloroethene	ND	2	NA	NA	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	570	NA	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	ND	850	NA	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	44	41	NA	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	ND	730	NA	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	ND	1300	NA	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	ND	1300	NA	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	42	790	NA	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	ND	1000	NA	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	55	1300	NA	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	ND	220	NA	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	ND	630	NA	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	180	NA	NA	240000	150	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	98	ND	NA	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	62	3600	NA	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	400	NA	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	ND	68	NA	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	ND	70	NA	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	57	3400	NA	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	70	3700	NA	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	14400	11400	NA	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	3.1	ND	NA	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	12.4	6.8	NA	NA	29	16.7	36	MG/KG	UG/L	NO	NO	NO
Barium	34.2	16.9	NA	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.75	0.32	NA	NA	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	1.8	0.12	NA	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	34	25.8	NA	NA	38	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	6.1	1.6	NA	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	65.4	6.2	NA	NA	920	1500	2.9	MG/KG	UG/L	NO	NO	NO
Lead	96.4	17.3	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	168	73.9	NA	NA	1100	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.37	0.1	NA	NA	2	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	20	3.8	NA	NA	130	730	61.1	MG/KG	UG/L	NO	NO	NO
Selenium	1.1	1.5	NA	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Vanadium	35	42	NA	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	1800	28.1	NA	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background reference value.

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

10.8.4.2 AOC 616 — Soil-to-Air Cross-Media Transport

Table 10.8.6 lists the VOCs detected in surface soil samples from AOC 616 and corresponding soil-to-air volatilization screening levels. Only one VOC — 2-butanone — was detected at AOC 616 in surface soil. Currently there is no applicable screening level for this VOC; however, surface soil at AOC 616 is paved, and the soil-to-air pathway is essentially invalid because migration is inhibited by the cover.

10.8.4.3 AOC 616 — Fate and Transport Summary

No constituents in surface or subsurface soil exceeded any soil screening levels. Therefore, no threat was identified to groundwater in the Cooper River. Additionally, even though one VOC was detected in surface soil, the soil-to-air migration pathway is inhibited due to pavement cover.

10.8.5 Human Health Risk Assessment

10.8.5.1 Site Background and Investigative Approach

AOC 616 is former Building 1201, which operated as a paint shop from 1955 to 1977. The building has since been demolished and the site incorporated into a parking and storage lot for Building 69. Materials released, stored, or disposed of at the site are paint thinner, solvents, and paint supply products.

During the investigation, eight soil samples in all were collected from four borings. No groundwater samples were collected. Section 10.8.3 summarizes the AOC 616 sampling effort.

10.8.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this CSI and presented in Table 10.8.7, the only COPC identified in surface soil is antimony. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out, based on background concentrations.

Table 10.8.7
Chemicals Present in Site Samples
AOC 616 - Surface Soil
Naval Base Charleston, Zone F
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration Residential RBC	Reference	Units	Number Exceeding RBC	Ref
Carcinogenic PAHs												
B(a)P Equiv.	1	4	4.255	4.255	4.26	415.98	439.09	88	NA	UG/KG		
Benzo(b)fluoranthene	1	4	42	42	42	180	190	880	NA	UG/KG		
Chrysene	1	4	55	55	55	180	190	88000	NA	UG/KG		
Inorganics												
Aluminum (Al)	4	4	3580	14400	6555	NA	NA	7800	18500	MG/KG	1	
Antimony (Sb) *	1	4	3.1	3.1	3.1	0.165	0.17	3.1	0.79	MG/KG	1	1
Arsenic (As)	4	4	0.86	12.4	4.24	NA	NA	0.43	19.9	MG/KG	4	
Barium (Ba)	4	4	3.5	34.2	12.35	NA	NA	550	61.5	MG/KG		
Beryllium (Be)	4	4	0.12	0.75	0.30	NA	NA	0.15	1.05	MG/KG	2	
Cadmium (Cd)	4	4	0.07	1.8	0.53	NA	NA	3.9	0.26	MG/KG		1
Calcium (Ca)	4	4	744	55000	18249	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	4	4	4.4	34	12.5	NA	NA	39	34.8	MG/KG		
Cobalt (Co)	3	4	0.79	6.1	2.58	0.305	0.305	470	15.1	MG/KG		
Copper (Cu)	1	4	65.4	65.4	65.4	0.355	1	310	48.2	MG/KG		1
Iron (Fe)	4	4	1210	17900	6013	NA	NA	NA	NA	MG/KG		
Lead (Pb)	2	4	5.2	96.4	50.8	1.1	1.35	400	180	MG/KG		
Magnesium (Mg)	4	4	211	2470	879	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	4	4	5.7	168	50.8	NA	NA	180	307	MG/KG		
Mercury (Hg)	1	4	0.37	0.37	0.37	0.02	0.02	2.3	0.62	MG/KG		
Nickel (Ni)	4	4	1.1	20	6.08	NA	NA	160	12.6	MG/KG		1
Potassium (K)	4	4	155	1140	409	NA	NA	NA	NA	MG/KG		
Selenium (Se)	3	4	0.57	1.1	0.82	0.17	0.17	39	1.15	MG/KG		
Sodium (Na)	4	4	150	386	227	NA	NA	NA	NA	MG/KG		
Vanadium (V)	4	4	3.9	35	13.0	NA	NA	55	48.9	MG/KG		
Zinc (Zn)	3	4	12.5	1800	665	2.2	2.2	2300	198	MG/KG		1
Semivolatile Organics												
Benzoic acid	1	4	44	44	44	900	900	31000000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)	1	4	98	98	98	180	190	46000	NA	UG/KG		
Fluoranthene	1	4	62	62	62	180	190	310000	NA	UG/KG		
Phenanthrene	1	4	57	57	57	180	190	310000	NA	UG/KG		
Pyrene	1	4	70	70	70	180	190	230000	NA	UG/KG		
Volatile Organic												
2-Butanone (MEK)	1	4	8	8	8	5.5	6	4700000	NA	UG/KG		

Notes:
* - indicates the constituent has been identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
PAH - Polyaromatic hydrocarbons
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available

10.8.5.3 Exposure Assessment

Exposure Setting

AOC 616 is in an industrial setting on the former naval base, 600 feet southwest of the waterfront area along the Cooper River. The site is surrounded by buildings and roads, railroad right-of-ways, and mostly paved storage/parking areas. The site is paved with asphalt, which would prevent direct contact with soil and inhibit migration of potential contaminants to groundwater or air. All potable water is provided through the city's water supply. Groundwater is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively relative to future workers and residents. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (much of the area is paved). Therefore, future worker assessment is considered to be protective of current site users. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for current and future site workers use are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. Table 10.8.8 presents the justification for exposure pathways assessed in this HHRA.

Table 10.8.8
Exposure Pathways Summary — AOC 616
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 616, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is currently used as a source of potable or non-residential water at AOC 616.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is currently used as a source of potable or non-residential water at AOC 616.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 616, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Groundwater, Ingestion of contaminants during potable or general use	No	Groundwater was not sampled during the AOC 616 RFI.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.

Table 10.8.8
Exposure Pathways Summary — AOC 616
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina, city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

Since less than ten samples were collected in surface soil, maximum detected concentrations were used as EPCs, as discussed in Section 7 of this RFI.

Quantification of Exposure

CDIs for incidental ingestion and dermal contact with surface soils are listed in Tables 10.8.9 and 10.8.10, respectively.

10.8.5.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.8.11 presents toxicological information specific to antimony, the only COPC identified at AOC 616. This information was used to quantify risk/hazard associated with surface soil contaminants. A brief toxicological profile for antimony is provided below:

Antimony is absorbed slowly through the gastrointestinal tract, which is the target of this element. Antimony has been experimentally shown to reduce lifespan, decrease blood glucose, and alter cholesterol levels, when tested on a population of mice. Due to frequent industrial use, the primary exposure route for antimony to the general population is food.

Table 10.8.9
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 616
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic							
Antimony (Sb)	1	3	4.2E-06	4.0E-05	4.9E-06	1.5E-06	5.4E-07

NOTES:

lwa	Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI	Chronic Daily Intake in mg/kg-day
H-CDI	CDI for hazard quotient
C-CDI	CDI for excess cancer risk
*	Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.8.10
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 616
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic								
Antimony (Sb)	1	3	0.001	1.7E-07	5.7E-07	1.1E-07	1.2E-07	4.4E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
\- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.8.11
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 616
NAVBASE Charleston, Zone F
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*			
emical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)	Inhalation Slope Factor (kg-day/mg)	Weight of Evidence	Tumor Type
timony	0.0004	a	L	whole body/blood increased mortality	1,000	NA	NA	NA	NA	NA	NA	D	NA

tes:

= Integrated Risk Information System (IRIS)

= Not applicable or not available

= Low confidence

Antimony is also a common air pollutant from industrial emissions. USEPA has posted an oral RfD of 0.0004 mg/kg-day, based on a LOAEL of 0.35 mg/kg-day and an uncertainty factor of 1,000. (Klaassen, et al., 1986).

10.8.5.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was computed separately to address child and adult exposure. Tables 10.8.12 and 10.8.13 present the computed HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The computed hazard indices for the adult resident were 0.01 for the soil ingestion pathway and 0.002 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 0.1 and 0.007, respectively. The sole contributor to cumulative HI projections is antimony.

Hypothetical Site Workers

Hazard indices for the ingestion and dermal pathways were projected to be 0.004 and 0.002 for the hypothetical site worker scenario, respectively.

COCs Identified

Identification of chemicals of concern was based on cumulative (all pathway) risk and hazard projected for this site medium specifically. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC,

Table 10.8.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 616
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganic							
Antimony (Sb)	0.0004	NA	0.011	0.10	NA	0.004	NA
SUM Hazard Index/ILCR			0.01	0.1	NA	0.004	NA

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.8.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 616
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganic								
Antimony (Sb)	0.2	0.00008	NA	0.0022	0.007	NA	0.0016	NA
SUM Hazard Index/ILCR				0.002	0.007	NA	0.002	NA

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, if its individual ILCR exceeds 1E-06 or its hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to more comprehensively evaluate chemicals contributing to carcinogenic risk or noncarcinogenic hazard during remedial goal options development. However, no COCs were identified in surface soils at AOC 616. Antimony was the only COPC identified, and it only yielded a cumulative HI of 0.1 in the future residential child scenario, which was the most conservative scenario used to assess risk at AOC 616. As a result, no COCs were identified for AOC 616.

10.8.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone F. If this area were to be used as a residential site, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentrations were used as exposure point concentrations for this site. Use of maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely for the maximum detected concentration to represent soil constituents throughout the site.

Frequency of Detection and Spatial Distribution

Antimony was detected in only one of four surface soil samples, indicating that it is not likely widespread throughout the site.

Quantification of Risk/Hazard

As indicated above, the uncertainty inherent in risk assessment is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

A conservative screening process was used to identify COPCs for AOC 616. The potential for eliminating CPSSs with the potential for cumulative HI greater than 1 was addressed for noncarcinogens through the use of RBCs reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs, combined with the use of maximum detected concentrations, reduces the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, manganese was reported at a concentration close to the RBC (e.g. within 10% of its RBC). Aluminum, arsenic, and beryllium were detected at maximum concentrations exceeding their corresponding RBCs and were eliminated based on comparison to their corresponding reference concentrations. Wilcoxon rank sum test analysis also indicated that these inorganics site concentrations were within background concentrations.

Background-Related Risk

Aluminum, arsenic, and beryllium in AOC 616 surface soil exceeded RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to background concentrations. It is not unusual for some element's naturally occurring or background concentrations to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following discusses the residential scenario risk/hazard associated with these element's background concentrations.

The maximum surface soil concentrations of aluminum (14,400 mg/kg), arsenic (12.4 mg/kg), and beryllium (0.75 mg/kg) for AOC 616 equate with hazard quotients of 0.2, 0.6, and 0.002, respectively, for the residential child scenario. The maximum surface soil concentrations of arsenic and beryllium also equate with ILCRs of 3E-05 and 6E-06, respectively; however the Zone F background surface soil concentrations for arsenic (19.9 mg/kg) and beryllium (1.05 mg/kg) equate with ILCRs of 5E-05, and 8E-06, respectively.

10.8.5.7 Risk Summary

The risk and hazard posed by AOC 616 contaminants were assessed for the future site worker and the future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.8.14 summarizes risk for each soil pathway/receptor group evaluated for AOC 616. No COCs were identified at AOC 616, indicating no threat to current or future human receptors.

10.8.6 Corrective Measures Considerations

For AOC 616, upper and lower soil intervals were investigated. Soil samples were collected at four locations. No groundwater monitoring wells were installed or sampled. Based on the analytical results and the human health risk assessment, no COCs requiring further evaluation

Table 10.8.14
Summary of Risk and Hazard
AOC 616
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.01	0.1	NA	0.004	NA
	Dermal Contact	0.002	0.007	NA	0.002	NA
Sum of Soil Pathways		0.01	0.1	NA	0.005	NA

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

through the CMS process were identified for an unlikely future residential use. Residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is paved with asphalt. All soil samples were collected from beneath the pavement.

No compounds were identified as COCs in the soil sampled at AOC 616.

10.9 AOC 617, Galvanizing Plant, Former Building 1176

A CSI site, AOC 617 is the former Building 1176, which operated as a galvanizing plant from the early 1940s to approximately 1985. A 3,000 gallon UST apparently was used for onsite chemical storage. The building has since been demolished and Building 69, a shipping and supply center was constructed in the general area. Materials released, stored or disposed of at the site included zinc solutions and inorganic acids.

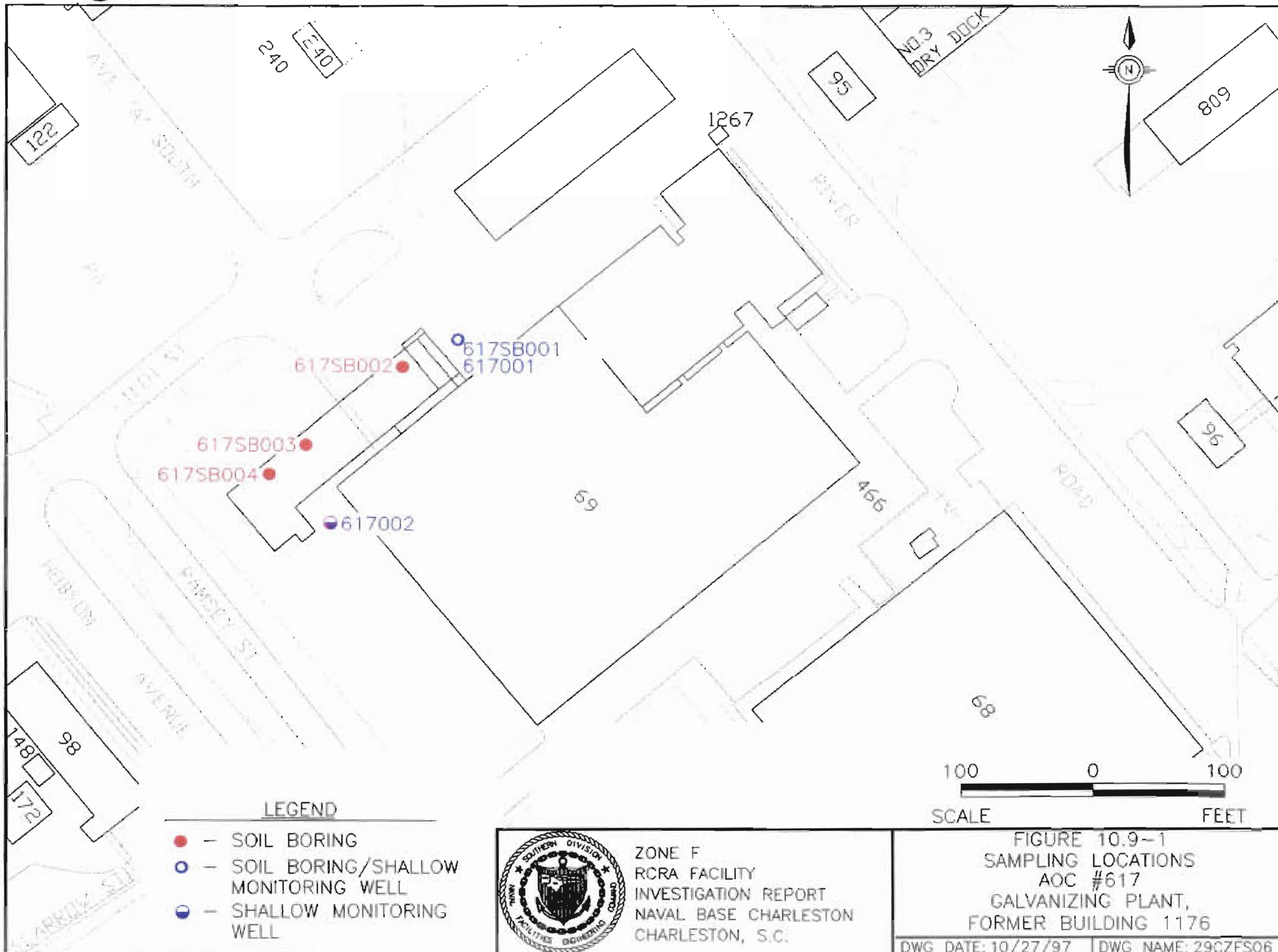
10.9.1 Site Geology and Hydrogeology

The soil boring and groundwater monitoring well locations at AOC 617 are shown in Figure 10.9-1. The stratigraphy at AOC 617, based on two monitoring well borings, consists of silty sand and silt overlying silty clay and clayey sand. No samples for grain size analysis were collected from the aquifer at this AOC. The silty clay extends to a depth of approximately 12 ft bgs. The total depth of monitoring well 617001 was 12.3 ft bgs while monitoring well 617002 had a total depth of 14.0 ft bgs. Boring logs and as-built well construction diagrams are contained in Appendix A.

Figure 10.9-2 depicts the shallow groundwater potentiometric surface and inferred flow direction at low tide. Figure 10.9-3 depicts the shallow groundwater potentiometric surface and inferred flow direction at high tide. Minor differences in the static water levels and the overall flow pattern at the AOC 617 area were observed between high and low tide. No slug tests were performed on the AOC 617 wells, therefore, no hydraulic conductivity could be calculated. The representative horizontal hydraulic gradient, based on Figure 10.9-2 is 1.8E-02.

10.9.2 Field Investigation Approach

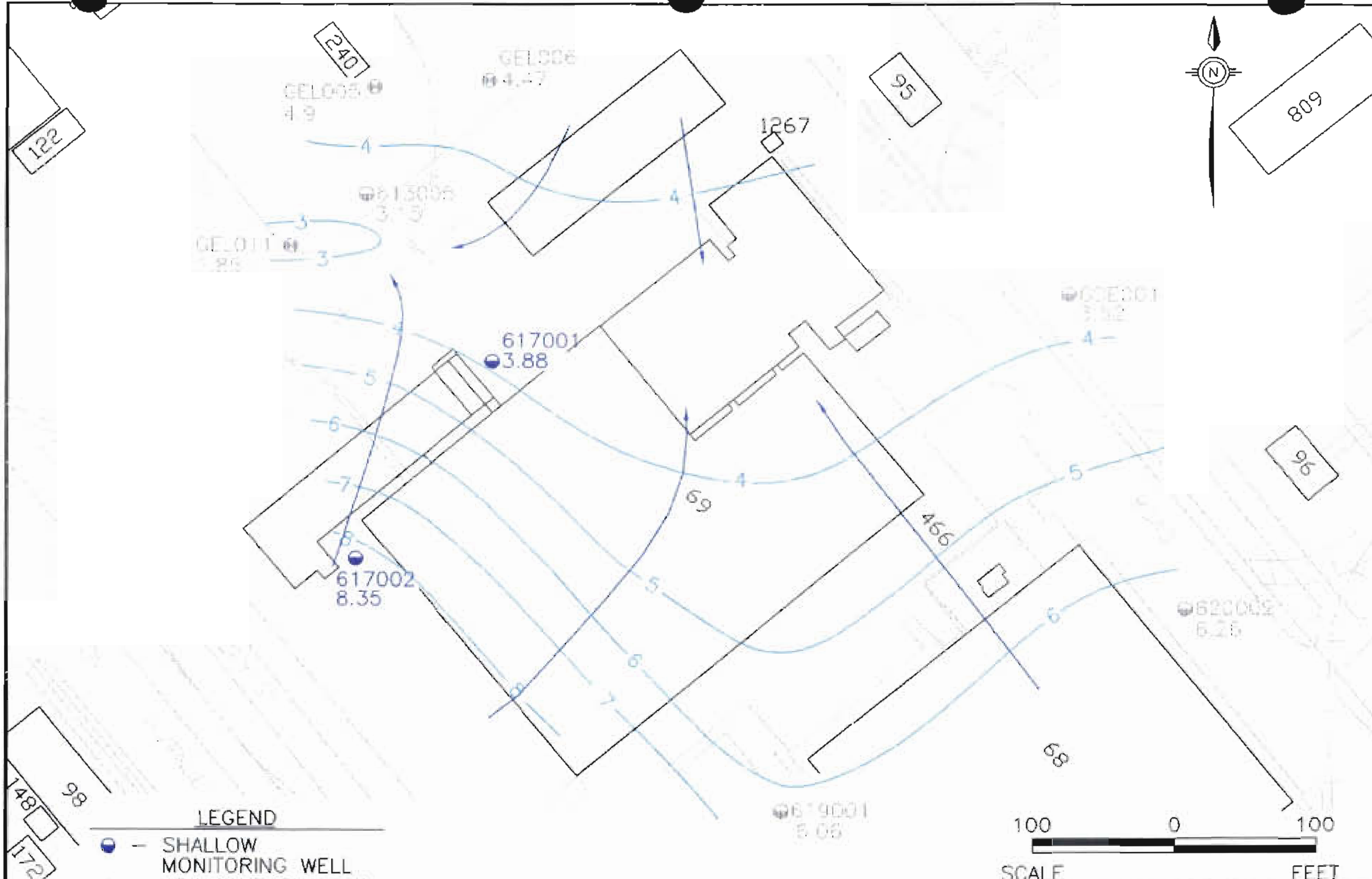
The objective of the field investigation at AOC 617 was to: (1) assess the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil and groundwater. Section 3 of this report details the methods



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.9–1
SAMPLING LOCATIONS
AOC #617
GALVANIZING PLANT,
FORMER BUILDING 1176

DWG DATE: 10/27/97 | DWG NAME: 29CZFS06



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RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
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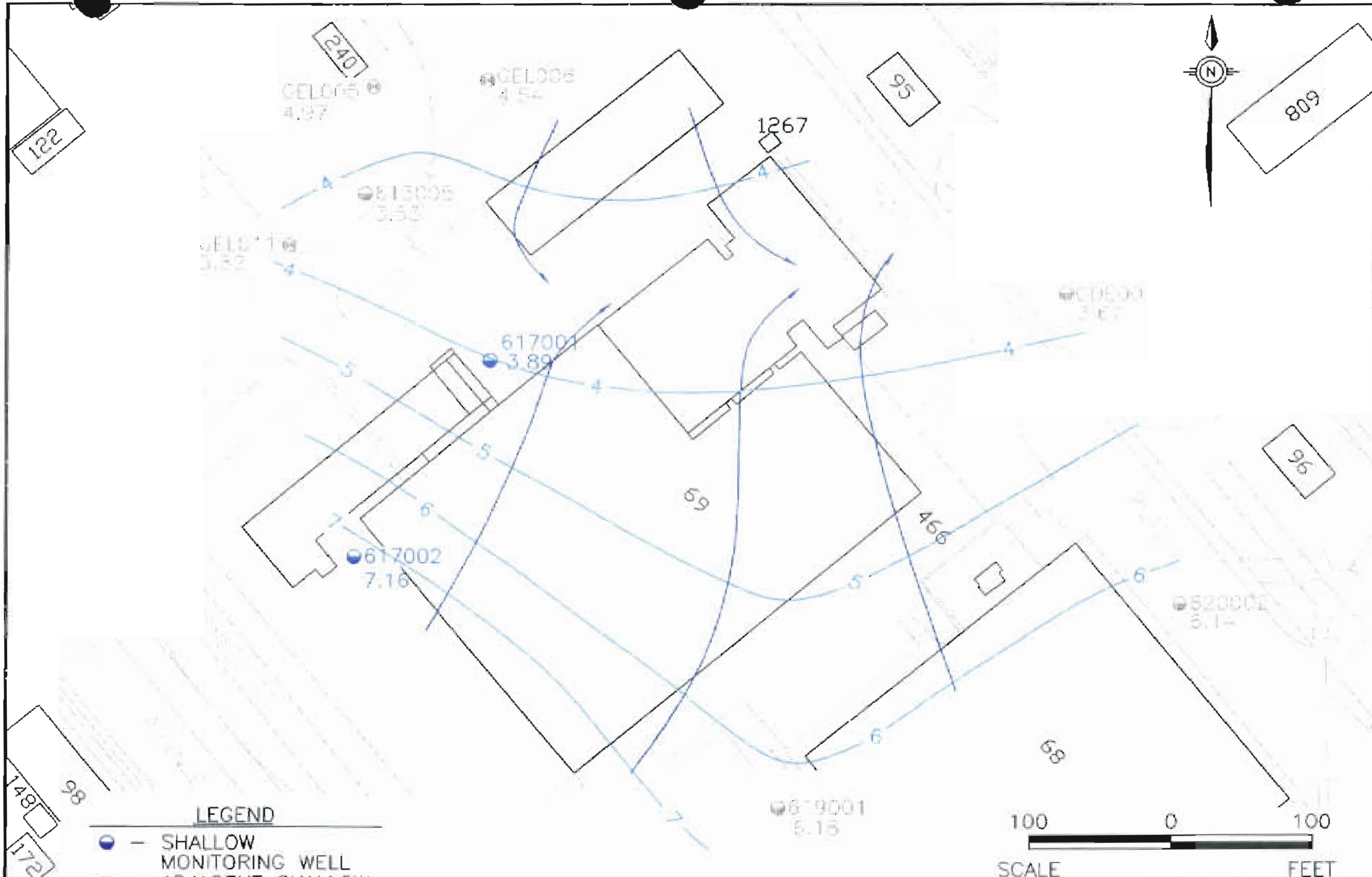
FIGURE 10.9–2
SHALLOW GROUNDWATER
LOW–TIDE POTENTIOMETRIC MAP
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 10/30/97 | DWG NAME: 2906GPLT



ZONE F
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FIGURE 10.9–3
SHALLOW GROUNDWATER HIGH–TIDE POTENTIOMETRIC MAP
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 10/30/97 | DWG NAME: 2906GPHT

used during the field investigation including hollow stem auger procedures used for shallow well installation; hand-auger procedures used for soil sampling; groundwater sampling procedures; analytical protocols for sample analyses; and miscellaneous field procedures used during the field investigation.

10.9.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing four soil borings within the AOC 617 area to assess the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed for each boring. Four soil borings were advanced during the field investigation, as depicted in Figure 10.9-1. Upper and lower interval samples were collected from each location. In accordance with the approved final RFI work plan, soil samples were analyzed for metals, SVOAs, and VOAs at DQO Level III, and pH. In addition, samples from all but one boring (617SB001) were analyzed for cyanide and pesticides. Duplicate samples included one lower interval soil sample collected for Appendix IX analyses at DQO Level IV. Table 10.9.1 summarizes the AOC 617 soil samples and analyses.

10.9.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.9.2. Inorganic analytical results for soil are summarized in Table 10.9.3. Table 10.9.4 presents a summary of all analytes detected in soil at AOC 617. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organic Compounds in Soil

No VOCs were detected in surface soil samples. No VOCs exceeded their respective SSLs in subsurface soil at AOC 617.

Table 10.9.1
AOC 617
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
617SB001	617SB00101 617SB00102	Upper Lower	8/29/96	Note 1	
617SB002	617SB00201 617SB00202 617CB00202*	Upper Lower	8/30/96	Note 1/cyanide; pesticides/PCB Note 2	Duplicate Sample*
617SB003	617SB00301 617SB00302	Upper Lower	8/30/96	Note 1/cyanide; pesticides/PCB	
617SB004	617SB00401 617SB00402	Upper Lower	8/30/96	Note 1/cyanide; pesticides/PCB	

Notes:

1 = SW-846 (metals, SVOAs, and VOAs); at DQO Level III; pH

2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOAs, VOAs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV

* = Duplicate sample

Table 10.9.2
AOC 617
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc[*] (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 4 Samples/Lower Interval - 4 Samples plus 1 Duplicate Sample) (µg/kg)						
Carbon Disulfide	**Upper**	**0/4**	**ND**	**ND**	**780000**	**0**
	Lower	**2/4**	**1.0 - 1.0**	**1.0**	**32000[a]**	**0**
Semivolatile Organic Compounds (Upper Interval - 4 Samples/Lower Interval - 4 Samples plus 1 Duplicate Sample) (µg/kg)						
BEQs[1]	**Upper**	**2/4**	**67.83 - 204.3**	**136.037**	**88.0**	**2**
	Lower	**0/0**	**NA**	**NA**	**NA**	**NA**
2-Methylnaphthalene	Upper	0/4	ND	ND	310000	0
	Lower	2/4	75 - 280	177.5	126000	0
Acenaphthene	**Upper**	**0/4**	**ND**	**ND**	**470000**	**0**
	Lower	**2/4**	**1000 - 2400**	**1700**	**570000[a]**	**0**
Anthracene	Upper	1/4	40	40	2300000	0
	Lower	2/4	3400 - 4200	3800	12000000[a]	0
Benzo(a)anthracene	**Upper**	**2/4**	**44 - 130**	**87**	**880**	**0**
	Lower	**4/4**	**85.5 - 5900**	**2945.63**	**2000[b]**	**2**
Benzo(a)pyrene	Upper	2/4	56 - 130	93	88	1
	Lower	4/4	110 - 5500	2687.5	8000	0
Benzo(b)fluoranthene	**Upper**	**2/4**	**69 - 82**	**75.5**	**880**	**0**
	Lower	**3/4**	**85 - 3700**	**1308.33**	**5000[b]**	**0**
Benzo(g,h,i)perylene	Upper	1/4	73	73	230000	0
	Lower	4/4	60 - 2800	1291.5	4.66E+08	0

Table 10.9.2
AOC 617
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc* (µg/kg)	Number of Samples Exceeding Reference
Benzo(k)fluoranthene	**Upper**	**2/4**	**47 - 110**	**78.5**	**8800**	**0**
	Lower	**4/4**	**100 - 6200**	**2742.5**	**49000[b]**	**0**
Benzoic acid	Upper	0/4	ND	ND	31000000	0
	Lower	1/4	130	130	400000[a,c]	0
Chrysene	**Upper**	**2/4**	**54 - 150**	**102**	**88000**	**0**
	Lower	**4/4**	**90 - 6200**	**2822.5**	**160000[b]**	**0**
Dibenz(a,h)anthracene	Upper	1/4	44	44	88	0
	Lower	3/4	45 - 1600	981.67	2000[b]	0
Dibenzofuran	**Upper**	**0/4**	**ND**	**ND**	**31000**	**0**
	Lower	**2/4**	**510 - 1200**	**855**	**240000**	**0**
Fluoranthene	Upper	2/4	84 - 220	152	310000	0
	Lower	4/4	53 - 14000	6805.75	4300000[a]	0
Fluorene	**Upper**	**0/4**	**ND**	**ND**	**310000**	**0**
	Lower	**2/4**	**1000 - 1900**	**1450**	**560000[a]**	**0**
Indeno(1,2,3-cd)pyrene	Upper	1/4	78	78	880	0
	Lower	4/4	59 - 2800	1369	14000[b]	0
Naphthalene	**Upper**	**0/4**	**ND**	**ND**	**310000**	**0**
	Lower	**2/4**	**240 - 870**	**555**	**84000[a]**	**0**
Phenanthrene	Upper	2/4	58 - 140	99	230000	0
	Lower	2/4	1100 - 12000	11500	1380000	0
Pyrene	**Upper**	**2/4**	**69 - 210**	**139.5**	**230000**	**0**
	Lower	**4/4**	**56 - 10000**	**5064**	**4200000[a]**	**0**

Table 10.9.2
AOC 617
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc* (μg/kg)	Number of Samples Exceeding Reference
bis(2-ethylhexyl)phthalate (BEHP)	Upper	1/4	91	91	46000	0
	Lower	3/4	77 - 390	272.33	3600000	0
Pesticides and PCBs (Upper Interval - 3 Samples/Lower Interval - 3 Samples) (μg/kg)						
4,4'-DDD	**Upper**	**1/3**	**4.3**	**4.3**	**2700**	**0**
	Lower	**1/3**	**4.45**	**4.45**	**16000[b]**	**0**
4,4'-DDE	Upper	1/3	3.0	3.0	1900	0
	Lower	2/3	21 - 51	36	54000[b]	0
4,4'-DDT	**Upper**	**0/3**	**ND**	**ND**	**1900**	**0**
	Lower	**1/3**	**100**	**100**	**32000[b]**	**0**
Aroclor-1260	Upper	0/3	ND	ND	320	0
	Lower	2/3	870 - 1700	1285	1000	1
Herbicides (Lower Interval - 1 Duplicate Sample) (μg/kg)						
2,4-D	**Upper**	**0/0**	**ND**	**ND**	**78000**	**0**
	Lower	**1/1**	**160**	**160**	**3400**	**0**
Dioxins (Lower Interval - 1 Duplicate Sample) (ng/kg)						
Dioxin (2,3,7,8-TCDD TEQs[1])	**Upper**	**0/0**	**ND**	**ND**	**1000**	**0**
	Lower	**1/1**	**0.1812**	**0.1812**	**1900**	**0**

Table 10.9.2
AOC 617
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc* (μg/kg)	Number of Samples Exceeding Reference
pH (Upper Interval - 4 Samples/Lower Interval - 4 Samples)						
pH	Upper	4/4	7.45 - 7.72	7.55	NL	NA
	Lower	4/4	7.1 - 7.97	7.45	NL	NA

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2, (USEPA, 1995b)
a	=	Calculated values correspond to a noncancer hazard quotient of 1
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000
c	=	SSL for pH of 6.8
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable BEQs are applicable to surface soil only
BEQ	=	Benzo(a)pyrene equivalents
μg/kg	=	Micrograms per kilogram
ng/kg	=	Nanograms per kilogram

Table 10.9.3
AOC 617
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 4 Samples/Lower Interval - 4 Samples plus 1 Duplicate Sample) (mg/kg)						
Aluminum	**Upper**	**4/4**	**3890 - 4580**	**4212.5**	**7800**	**0**
	Lower	**4/4**	**2380 - 15300**	**7353.75**	**1000000**	**0**
Antimony	Upper	0/4	ND	ND	3.1	0
	Lower	2/4	5.5 - 10.7	8.1	5	2
Arsenic	**Upper**	**4/4**	**0.97 - 2.6**	**1.67**	**0.43**	**4**
	Lower	**4/4**	**1.3 - 15.5**	**6.03**	**29[b]**	**0**
Barium	Upper	4/4	3.4 - 10.4	7.28	550	0
	Lower	4/4	19.8 - 36.1	27.05	1600[b]	0
Beryllium	**Upper**	**4/4**	**0.11 - 0.21**	**0.16**	**0.15**	**2**
	Lower	**4/4**	**0.09 - 0.98**	**0.40**	**63[b]**	**0**
Cadmium	Upper	2/4	0.15 - 0.27	0.21	3.9	0
	Lower	4/4	0.2 - 0.82	0.40	8[b]	0
Calcium	**Upper**	**4/4**	**924 - 25100**	**8981.0**	**NL**	**NA**
	Lower	**4/4**	**2040 - 14600**	**6946.25**	**NL**	**NA**
Chromium	Upper	4/4	4.1 - 7.5	5.8	39	0
	Lower	4/4	6.1 - 26.0	13.14	38[b]	0
Cobalt	**Upper**	**4/4**	**0.57 - 3.0**	**1.34**	**470**	**0**
	Lower	**4/4**	**0.77 - 6.4**	**2.53**	**2000**	**0**
Copper	Upper	2/4	4.0 - 4.1	4.05	310	0
	Lower	4/4	9.4 - 33.2	18.61	920	0

Table 10.9.3
AOC 617
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Iron	**Upper**	**4/4**	**1580 - 3830**	**2715**	**2300**	**3**
	Lower	**4/4**	**2480 - 23000**	**9401.25**	**NL**	**NA**
Lead	Upper	2/4	11.2 - 14.9	13.05	400[c]	0
	Lower	4/4	49.8 - 274	126.3	400[c]	0
Magnesium	**Upper**	**4/4**	**213 - 689**	**371.75**	**NL**	**NA**
	Lower	**4/4**	**217 - 3220**	**1212**	**NL**	**NA**
Manganese	Upper	4/4	9.5 - 44.5	19.7	180	0
	Lower	4/4	7.9 - 215	89.29	1100	0
Mercury	**Upper**	**0/4**	**ND**	**ND**	**2.3**	**0**
	Lower	**4/4**	**0.28 - 1.5**	**0.84**	**2.0[b]**	**0**
Nickel	Upper	4/4	1.1 - 3.3	2.08	160	0
	Lower	4/4	4.1 - 44	15.31	130[b]	0
Potassium	**Upper**	**4/4**	**110 - 214**	**150.25**	**NL**	**NA**
	Lower	**4/4**	**110 - 1570**	**586.88**	**NL**	**NA**
Selenium	Upper	2/4	0.42 - 0.61	0.52	39	0
	Lower	4/4	0.39 - 0.89	0.65	5[b]	0
Sodium	**Upper**	**4/4**	**138 - 203**	**173.75**	**NL**	**NA**
	Lower	**4/4**	**144 - 596**	**278.63**	**NL**	**NA**
Thallium	Upper	1/4	0.39	0.39	0.63	0
	Lower	0/4	ND	ND	1.24	0

Table 10.9.3
AOC 617
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Tin	**Upper**	**0/4**	**ND**	**ND**	**4700**	**0**
	Lower	**3/4**	**1.8 - 33.9**	**15.73**	**11000**	**0**
Vanadium	Upper	4/4	3.5 - 8.6	6.38	55	0
	Lower	4/4	3.7 - 49.2	18.56	6000[a]	0
Zinc	**Upper**	**3/4**	**24.5 - 284**	**116.33**	**2300**	**0**
	Lower	**4/4**	**87 - 316**	**211.25**	**12000[a,b]**	**0**
Cyanide	Upper	3/3	0.16 - 0.36	0.29	160	0
	Lower	1/3	0.12	0.12	40 (amenable)	0

Notes:

a = Calculated values correspond to a noncancer hazard quotient of 1
b = SSL for pH of 6.8
c = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1995b)
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (μg/kg)							
Carbon disulfide	**617SB002**	**ND**	**780000**	**NA**	**1.0**	**32000[a]**	**NA**
	617SB003	**ND**			**1.0**		
Semivolatile Organic Compounds (μg/kg)							
BEQ[1]	**617SB001**	**67.82**	**88.0**	**NA**	**NA**	**NL**	**NA**
	617SB002	**ND**					
	617SB003	**ND**					
	617SB004	**204.25**					
2-Methylnaphthalene	617SB003	ND	310000	NA	75	126000	NA
	617SB004	ND			280		
Acenaphthene	**617SB003**	**ND**	**470000**	**NA**	**1000**	**570000[a]**	**NA**
	617SB004	**ND**			**2400**		
Anthracene	617SB003	ND	2300000	NA	3400	12000000[a]	NA
	617SB004	40			4200		
Benzo(a)anthracene	**617SB001**	**44**	**880.0**	**NA**	**97**	**2000[a]**	**NA**
	617SB002	**ND**			**85.5**		
	617SB003	**ND**			**5900**		
	617SB004	**130**			**5700**		
Benzo(a)pyrene	617SB001	56	88.0	NA	110	8000	NA
	617SB002	ND			140		
	617SB003	ND			5500		
	617SB004	130			5000		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(b)fluoranthene	617SB001	69	88.0	NA	85	5000[b]	NA
	617SB002	ND			140		
	617SB003	ND			3700		
	617SB004	82			ND		
Benzo(g,h,i)perylene	617SB001	ND	230000	NA	60	4.66E+08	NA
	617SB002	ND			106		
	617SB003	ND			2800		
	617SB004	73			2200		
Benzo(k)fluoranthene	617SB001	47	8800.0	NA	100	49000[b]	NA
	617SB002	ND			270		
	617SB003	ND			4400		
	617SB004	110			6200		
Benzoic acid	617SB001	ND	31000000	NA	130	400000[a,c]	NA
Chrysene	617SB001	54	88000.0	NA	90	160000[b]	NA
	617SB002	ND			200		
	617SB003	ND			6200		
	617SB004	150			5000		
Dibenz(a,h)anthracene	617SB002	ND	88	NA	45	2000[b]	NA
	617SB003	ND			1600		
	617SB004	44			1300		
Dibenzofuran	617SB003	ND	31000	NA	510	240000	NA
	617SB004	ND			1200		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Fluoranthene	617SB001	84	310000.0	NA	170	4300000[a]	NA
	617SB002	ND			53		
	617SB003	ND			14000		
	617SB004	220			13000		
Fluorene	**617SB003**	**ND**	**310000**	**NA**	**1000**	**560000[a]**	**NA**
	617SB004	**ND**			**1900**		
Indeno(1,2,3-cd)pyrene	617SB001	ND	880	NA	59	14000[b]	NA
	617SB002	ND			117		
	617SB003	ND			2800		
	617SB004	78			2500		
Naphthalene	**617SB003**	**ND**	**310000**	**NA**	**240**	**84000[a]**	**NA**
	617SB004	**ND**			**870**		
Phenanthrene	617SB001	58	230000.0	NA	ND	1380000	NA
	617SB003	ND			11000		
	617SB004	140			12000		
Pyrene	**617SB001**	**69**	**230000.0**	**NA**	**200**	**4200000[a]**	**NA**
	617SB002	**ND**			**56**		
	617SB003	**ND**			**10000**		
	617SB004	**210**			**10000**		
bis(2-ethylhexyl)phthalate (BEHP)	617SB001	ND	46000	NA	77	3600000	NA
	617SB003	ND			350		
	617SB004	91			390		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pesticides and PCBs (μg/kg)							
4,4'-DDD	**617SB002**	**ND**	**2700**	**NA**	**4.45**	**16000[b]**	**NA**
	617SB004	**4.3**			**ND**		
4,4'-DDE	617SB003	ND	1900.0	NA	21	54000[b]	NA
	617SB004	3.0			51		
4,4-DDT	**617SB003**	**ND**	**1900**	**NA**	**100**	**32000[b]**	**NA**
Aroclor-1260	617SB003	ND	320	NA	**1700**	1000	NA
	617SB004	ND			870		
Herbicides (μg/kg)							
2,4-D	**617SB002**	**ND**	**78000**	**NA**	**160**	**3400**	**NA**
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs[c])	**617SB002**	**ND**	**1000**	**NA**	**0.1812**	**1900**	**NA**
pH							
	617SB001	**7.72**	**NL**	**NA**	**7.39**	**NL**	**NA**
	617SB002	**7.55**			**7.97**		
	617SB003	**7.45**			**7.10**		
	617SB004	**7.49**			**7.33**		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	**617SB001**	**4310**	**7800.0**	**18500**	**15300**	**1000000**	**17100**
	617SB002	**4070**			**6435**		
	617SB003	**3890**			**2380**		
	617SB004	**4580**			**5300**		
Antimony (Sb)	617SB003	ND	3.1	0.79	**10.7**	5	NL
	617SB004	ND			**5.5**		
Arsenic (As)	**617SB001**	**1.3**	**0.43**	**19.9**	**15.5**	**29[c]**	**18.2**
	617SB002	**1.8**			**5.8**		
	617SB003	**0.97**			**1.3**		
	617SB004	**2.6**			**1.5**		
Barium (Ba)	617SB001	10.4	550.0	61.5	27.4	1600[c]	51.8
	617SB002	5.5			19.8		
	617SB003	3.4			36.1		
	617SB004	9.8			24.9		
Beryllium (Be)	**617SB001**	**0.14**	**0.15**	**1.05**	**0.98**	**63[c]**	**1.20**
	617SB002	**0.17**			**0.42**		
	617SB003	**0.11**			**0.12**		
	617SB004	**0.21**			**0.09**		
Cadmium (Cd)	617SB001	0.15	3.9	0.26	0.2	8[c]	0.09
	617SB002	ND			0.82		
	617SB003	ND			0.32		
	617SB004	0.27			0.25		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Calcium (Ca)	**617SB001**	**4400**	NL	NL	**5710**	NL	NL
	617SB002	**924**			**5435**		
	617SB003	**5500**			**14600**		
	617SB004	**25100**			**2040**		
Chromium (Cr)	617SB001	6.2	39 VI	34.8	26	38[c] (total)	32.2
	617SB002	5.4	7800 III		11.75		
	617SB003	4.1			6.1		
	617SB004	7.5			8.7		
Cobalt (Co)	**617SB001**	**3.0**	470.0	15.1	**6.4**	2000	6.85
	617SB002	**0.6**			**1.85**		
	617SB003	**0.57**			**1.1**		
	617SB004	**1.2**			**0.77**		
Copper (Cu)	617SB001	4.1	310.0	48.2	21.5	920	30.4
	617SB002	ND			10.35		
	617SB003	ND			33.2		
	617SB004	4.0			9.4		
Cyanide (Cn)	**617SB002**	**0.36**	160.0	0.29	**0.12**	40 (Amenable)	0.24
	617SB003	**0.16**			**ND**		
	617SB004	**0.35**			**ND**		
Iron (Fe)	617SB001	**2840**	2300.0	NL	**23000**	NL	NL
	617SB002	**2610**			**9550**		
	617SB003	1580			**2480**		
	617SB004	**3830**			**2570**		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Lead (Pb)	**617SB001**	**14.9**	**400.0[d]**	**180**	**49.8**	**400[d]**	**51.7**
	617SB002	**ND**			**60.4**		
	617SB003	**ND**			**274**		
	617SB004	**11.2**			**121**		
Magnesium (Mg)	617SB001	317	NL	NL	3220	NL	NL
	617SB002	213			762		
	617SB003	268			649		
	617SB004	689			217		
Manganese (Mn)	**617SB001**	**15.1**	**180.0**	**307**	**215**	**1100**	**469**
	617SB002	**9.5**			**108.85**		
	617SB003	**9.8**			**25.4**		
	617SB004	**44.5**			**7.9**		
Mercury (Hg)	617SB001	ND	2.3	0.62	0.28	2[c]	0.23
	617SB002	ND			0.93		
	617SB003	ND			0.64		
	617SB004	ND			1.5		
Nickel (Ni)	**617SB001**	**2.5**	**160.0**	**12.6**	**9.0**	**130[c]**	**8.85**
	617SB002	**1.1**			**4.15**		
	617SB003	**1.4**			**44**		
	617SB004	**3.3**			**4.1**		
Potassium (K)	617SB001	139	NL	NL	1570	NL	NL
	617SB002	138			514.5		
	617SB003	110			110		
	617SB004	214			153		

Table 10.9.4
AOC 617
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Selenium (Se)	**617SB001**	**0.61**	**39.0**	**1.15**	**0.89**	**5[c]**	**1.24**
	617SB002	**0.42**			**0.62**		
	617SB003	**ND**			**0.68**		
	617SB004	**ND**			**0.39**		
Sodium (Na)	617SB001	203	NL	NL	596	NL	NL
	617SB002	163			221.5		
	617SB003	138			144		
	617SB004	191			153		
Thallium (Tl)	**617SB001**	**0.39**	**0.63**	**NL**	**ND**	**1.24**	**1.24**
Tin (Sn)	617SB002	ND	4700	9.38	1.8	11000	NL
	617SB003	ND			33.9		
	617SB004	ND			11.5		
Vanadium (V)	**617SB001**	**6.6**	**55.0**	**48.9**	**49.2**	**6000[a]**	**49.4**
	617SB002	**6.8**			**15.65**		
	617SB003	**3.5**			**3.7**		
	617SB004	**8.6**			**5.7**		
Zinc (Zn)	617SB001	40.5	2300.0	198	87.0	12000[a,c]	84.2
	617SB002	ND			316		
	617SB003	24.5			296		
	617SB004	284.0			146		

Notes:

a	=	Calculated values correspond to a noncancer hazard quotient of 1
b	=	Calculated values correspond to a cancer risk level of 1 in 1,000,000
c	=	SSL for pH of 6.8
d	=	A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a)
1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
DAF	=	Dilution Attenuation Factor
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable
BEQ	=	Benzo(a)pyrene equivalents
mg/kg	=	Milligrams per kilogram
ng/kg	=	Nanograms per kilogram
µg/kg	=	Micrograms per kilogram
TEQ	=	TCDD Equivalency Quotient
THQ	=	Target Hazard Quotient

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background

All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group

Semivolatile Organic Compounds in Soil

Benzo(a)pyrene exceeded its RBC in one surface soil sample at AOC 617. Benzo(a)anthracene was detected in subsurface soil in two locations exceeding its SSL. Figure 10.9-4 presents the distribution of BEQs in surface soil. Figure 10.9-5 presents the distribution of benzo(a)anthracene in subsurface soil at AOC 617.

Pesticides and PCBs in Soil

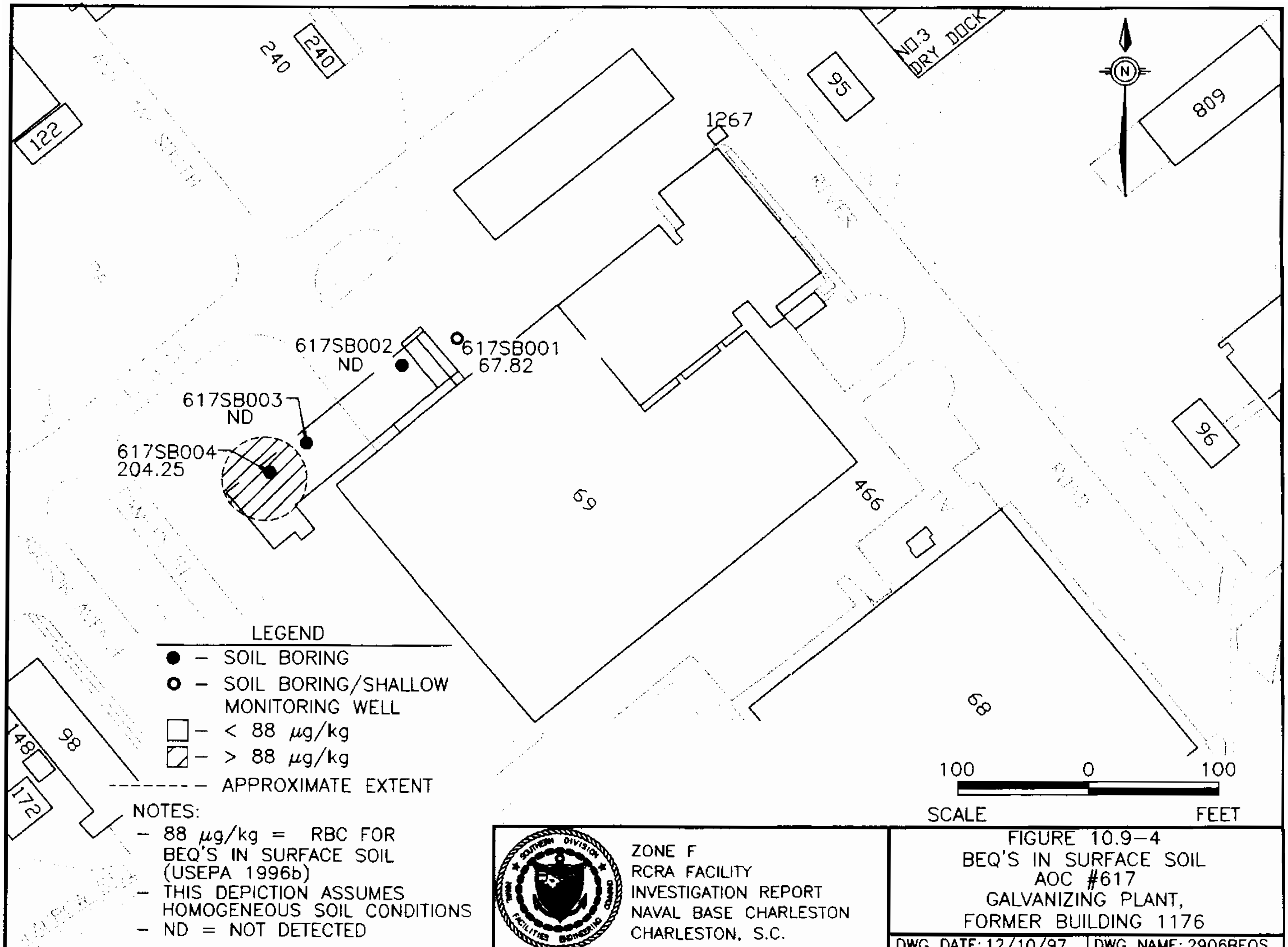
No pesticide concentrations exceeded their RBCs or SSLs in surface or subsurface soil samples at AOC 617. Aroclor-1260 was detected in two subsurface samples. The detection at 617SB003 exceeded the SSL. Figure 10.9-6 presents the detections of Arclor-1260 in subsurface soil.

Other Organic Compounds in Soil

The herbicide 2,4-D and dioxin (2,3,7,8-TCDD TEQ) were detected in the duplicate subsurface soil sample collected at 617SB002. Neither of these detections exceed the respective SSL.

Inorganic Elements in Soil

Twenty-three metals and cyanide were detected in soil samples collected at AOC 617. No inorganic concentrations were detected in surface soil samples that exceeded both their respective RBCs and background concentrations for Zone F surface soil. Iron exceeded its RBC in three surface soil samples but it does not have a background concentration because it is an essential nutrient. Antimony was detected in subsurface soil exceeding its SSLs; no antimony background concentration for subsurface soil is available. Figure 10.9-7 presents the distribution of antimony in subsurface soil at AOC 617.



ZONE F
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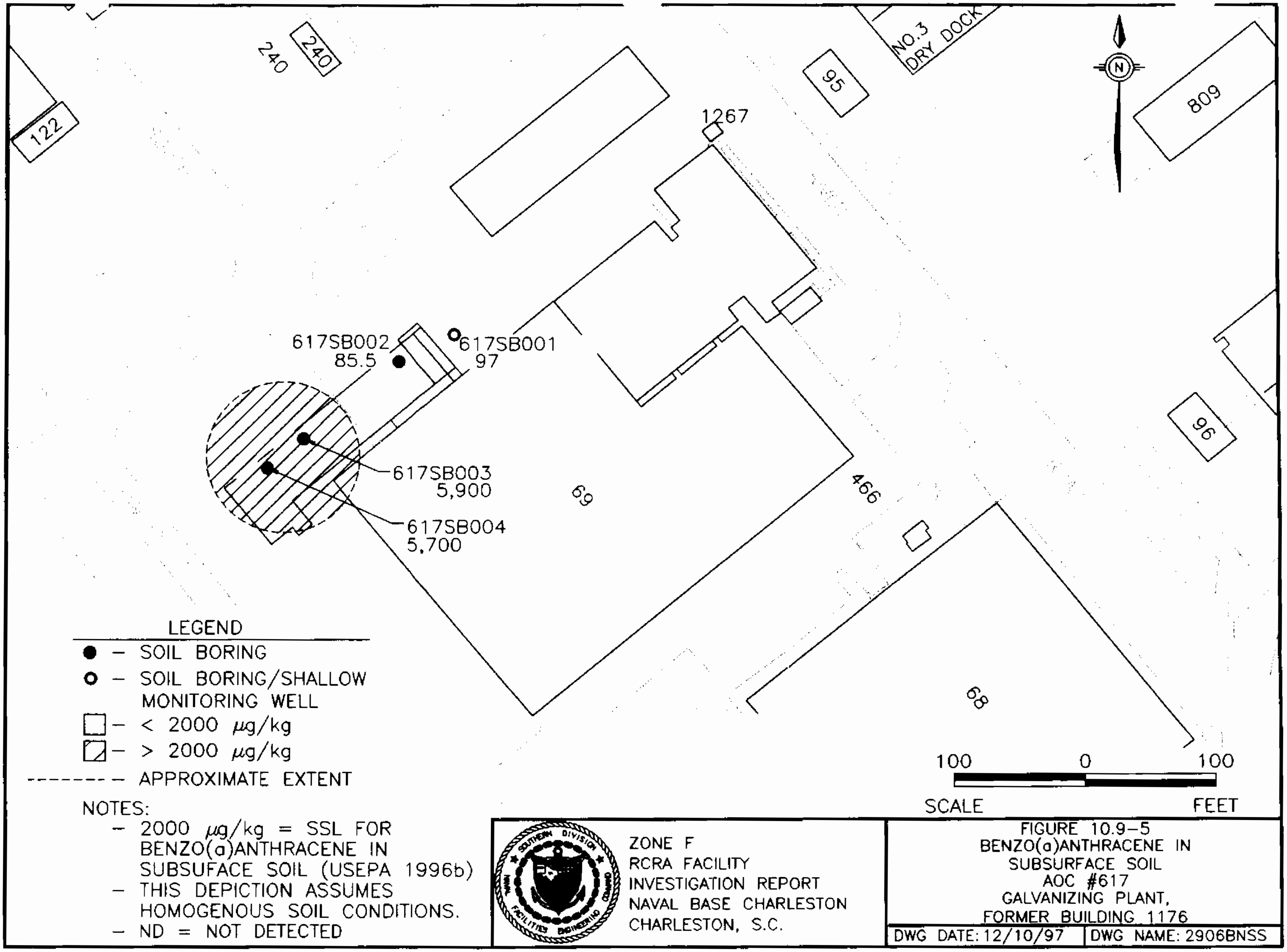
FIGURE 10.9–4
BEQ'S IN SURFACE SOIL
AOC #617
GALVANIZING PLANT,
FORMER BUILDING 1176

DWG DATE: 12/10/97 | DWG NAME: 2906BEQS



240
240
122
NO.3 DRY DOCK
95
1267
809
617SB002
85.5
617SB001
97
617SB003
5,900
617SB004
5,700
69
466
96
68
LEGEND
● – SOIL BORING
○ – SOIL BORING/SHALLOW MONITORING WELL
– < 2000 μg/kg
– > 2000 μg/kg
-------- APPROXIMATE EXTENT
NOTES:
– 2000 μg/kg = SSL FOR BENZO(a)ANTHRACENE IN SUBSUFACE SOIL (USEPA 1996b)
– THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS.
– ND = NOT DETECTED
100
0
100
SCALE
FEET
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FIGURE 10.9–5
BENZO(a)ANTHRACENE IN
SUBSURFACE SOIL
AOC #617
GALVANIZING PLANT,
FORMER BUILDING 1176
DWG DATE: 12/10/97
DWG NAME: 2906BNSS

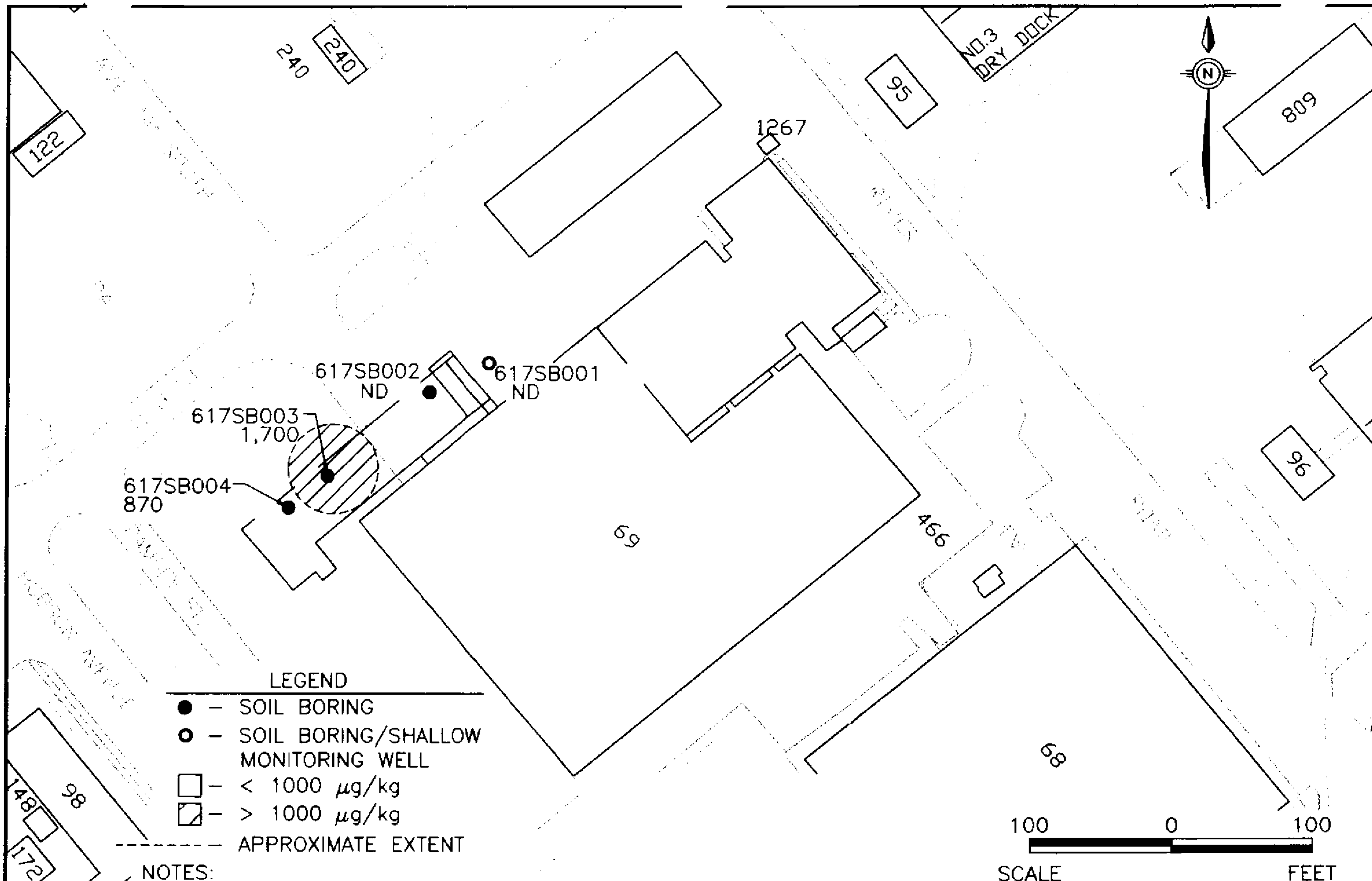

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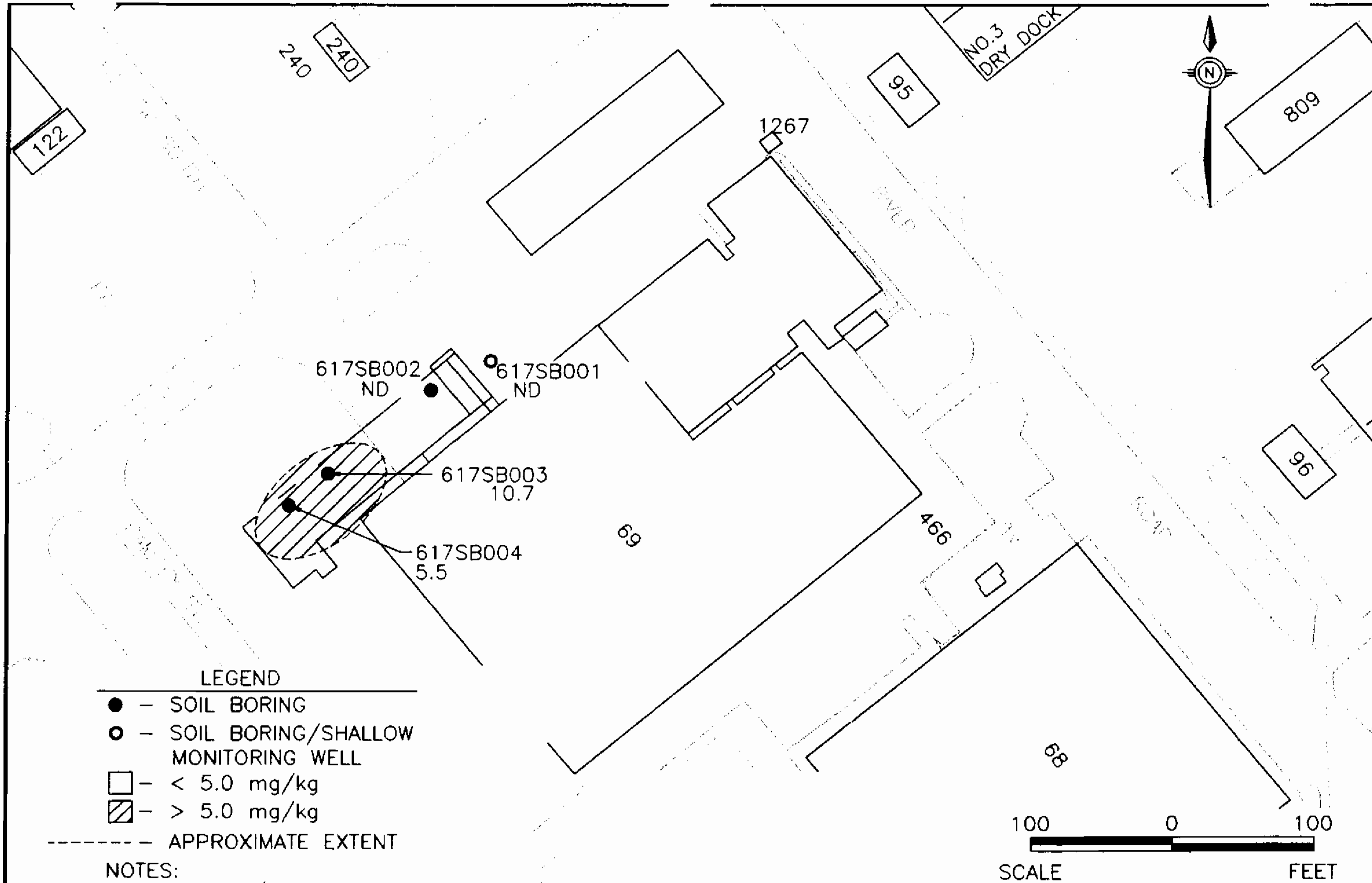
FIGURE 10.9-6
AROCLOR-1260 IN SUBSURFACE SOIL
AOC #617
GALVANIZING PLANT,
FORMER BUILDING 1176

DWG DATE: 12/10/97 | DWG NAME: 2906ASSL



LEGEND

- ● – SOIL BORING
- ○ – SOIL BORING/SHALLOW MONITORING WELL
- ☐ – < 5.0 mg/kg
- ▨ – > 5.0 mg/kg
- -------- APPROXIMATE EXTENT

NOTES:
- 5.0 mg/kg = SSL FOR ANTIMONY IN SUBSURFACE SOIL (USEPA 1996b)
- THIS DEPICTION ASSUMES HOMOGENOUS SOIL CONDITIONS
- ND = NOT DETECTED

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FIGURE 10.9-7
ANTIMONY IN SUBSURFACE SOIL
AOC #617
GALVANIZING PLANT,
FORMER BUILDING 1176

DWG DATE: 12/10/97 | DWG NAME: 2906ATSS

10.9.4 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of one shallow monitoring well within the AOC 617 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. During the field investigation, two shallow monitoring wells (as shown in Figure 10.9-1) were installed in two phases. These wells were installed between approximately 12 and 14 ft bgs. The first shallow well was installed as specified in the approved final RFI work plan. Later, a second well was installed to define the potential downgradient impact to groundwater from subsurface soil PCB/SVOA contamination identified during the site soil sampling. In accordance with the approved final RFI work plan, groundwater samples from these wells were analyzed for metals, SVOAs, and VOAs at DQO Level III, and pH. Table 10.9.5 summarizes the AOC 617 groundwater samples and analyses at AOC 617.

Table 10.9.5
AOC 617
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
617001	Shallow	61700101	11/14/96	See note	
617002	Shallow	617002A1	5/06/97	See note	Sample from second-round well.

Note:
SW-846 (metals, SVOAs, VOAs) at DQO Level III; pH

Nature of Contamination in Groundwater

In accordance with the work plan, well 617001 was installed initially. Well 617002 was installed subsequently to further evaluate site groundwater and was first sampled during the second quarter sampling event (May 1997). Organic analytical results for groundwater are summarized in Table 10.9.6. Inorganic analytical results for groundwater are summarized in Table 10.9.7. Table 10.9.8 presents a summary of all analytes detected in groundwater at AOC 617.

Table 10.9.6
AOC 617
Organic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Semivolatile Organic Compound (2 Shallow Samples) (μg/L)							
Butylbenzylphthalate	Shallow	1/2	1.0	1.0	730	NL	0

Notes:
MCL = Maximum Contaminant Level
NL = Not listed
SMCL = Secondary Maximum Contaminant Level
μg/L = Micrograms per liter
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table*, January-June 1996 (USEPA 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA 1996e) were used as reference concentrations
617002 (additional well) is included in calculations for this table
Data presented are from the initial sampling event only

Table 10.9.7
AOC 617
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Inorganics (2 Shallow Samples) (μg/L)							
Aluminum	**Shallow**	**2/2**	**1450 - 7420**	**4435**	**3700**	**50**	**1**
Arsenic	Shallow	1/2	31.7	31.7	0.045	50	1
Barium	**Shallow**	**1/2**	**52.9**	**52.9**	**260**	**2000**	**0**
Cadmium	Shallow	1/2	5.6	5.6	1.8	5	1
Calcium	**Shallow**	**2/2**	**20300 - 441000**	**230650**	**NL**	**NL**	**NA**
Chromium	Shallow	1/2	9.2	9.2	18	100	0
Cobalt	**Shallow**	**2/2**	**1.6 - 298**	**149.8**	**220**	**NL**	**1**
Iron	Shallow	2/2	16700 - 314000	165350	1100	300	2
Lead	**Shallow**	**1/2**	**10.5**	**10.5**	**15**	**15**	**0**
Magnesium	Shallow	2/2	4170 - 225000	114585	NL	NL	NA
Manganese	**Shallow**	**2/2**	**281 - 4850**	**2565.5**	**84**	**50**	**2**
Mercury	Shallow	1/2	0.18	0.18	1.1	2	0
Nickel	**Shallow**	**2/2**	**4.5 - 604**	**304.25**	**73**	**100**	**1**
Potassium	Shallow	2/2	3620 - 3660	3640	NL	NL	NA
Selenium	**Shallow**	**2/2**	**4.9 - 6.5**	**5.7**	**18**	**50**	**0**

Table 10.9.7
AOC 617
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Sodium	Shallow	2/2	179000 - 866000	522500	NL	NL	NA
Thallium	Shallow	1/2	21	21	0.29	2	1
Vanadium	Shallow	1/2	18.6	18.6	26	NL	0
Zinc	Shallow	2/2	37.6 - 145000	72518.8	1100	5000	1
pH							
pH	Shallow	2/2	4.95 - 6.27	5.61	NL	NL	NA

Notes:

MCL	=	Maximum contaminant level
SMCL	=	Secondary maximum contaminant level
NL	=	Not listed
NA	=	Not applicable
μg/L	=	Micrograms per liter
*	=	Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table*, January-June 1996, (USEPA 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA 1996e) were used as reference concentrations

617002 (additional well) is included in calculations for this table
Data presented are from the initial sampling event only

Table 10.9.8
AOC 617
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* ($\mu g/L$)	MCL/SMCL* ($\mu g/L$)	Shallow Background
Semivolatile Organic Compounds ($\mu g/L$)							
Benzoic Acid	**617002**	**NI**	**ND**	**5**	**15000**	**NL**	**NL**
Butylbenzylphthalate	617002	NI	1.0	ND	730	NL	NL
Inorganics ($\mu g/L$)							
Aluminum (Al)	617001	**7420**	1220	**10400**	3700	50	224
	617002	NI	1450	**153**			
Arsenic (As)	**617001**	**31.7**	**7.9**	**18.6**	**0.045**	**50**	**16.7**
Barium (Ba)	617001	52.9	34.9	69.4	260	2000	94.3
	617002	NI	ND	74.8			
Cadmium (Cd)	**617002**	**NI**	**5.6**	**ND**	**1.8**	**5**	**0.82**
Calcium (Ca)	617001	20300	23500	59300	NL	NL	NL
	617002	NI	441000	140000			
Chromium (Cr)	**617001**	**9.2**	**2.7**	**13.6**	**18**	**100**	**2.05**
Cobalt (Co)	617001	1.6	ND	2.8	220	NL	10.9
	617002	NI	**298**	16.6			
Copper (Cu)	**617001**	**ND**	**4.7**	**5.6**	**150**	**1000**	**NL**
Iron (Fe)	617001	**16700**	3120	**12000**	1100	300	NL
	617002	NI	**314000**	**314000**			
Lead (Pb)	**617001**	**10.5**	**ND**	**7.5**	**15**	**15**	**NL**

Table 10.9.8
AOC 617
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Magnesium (Mg)	617001	4170	6280	11800	NL	NL	NL
	617002	NI	225000	24100			
Manganese (Mn)	**617001**	**281**	**175**	**504**	**84**	**50**	**2010**
	617002	**NI**	**4850**	**733**			
Mercury (Hg)	617001	0.18	0.24	0.28	1.1	2	NL
	617002	NI	ND	0.12			
Nickel (Ni)	**617001**	**4.5**	**ND**	**ND**	**73**	**100**	**5.55**
	617002	**NI**	**604**	**44.6**			
Potassium (K)	617001	3620	4780	9100	NL	NL	NL
	617002	NI	3660	8890			
Selenium (Se)	**617001**	**4.9**	**ND**	**ND**	**18**	**50**	**NL**
	617002	**NI**	**6.5**	**ND**			
Sodium (Na)	617001	179000	168000	153000	NL	NL	NL
	617002	NI	866000	78500			
Thallium (Tl)	**617002**	**NI**	**21.0**	**ND**	**0.29**	**2**	**5.58**
Vanadium (V)	617001	18.6	3.9	20.8	26	NL	1.58
Zinc (Zn)	**617001**	**37.6**	**21.8**	**ND**	**1100**	**5000**	**NL**
	617002	**NI**	**145000**	**1100**			

Table 10.9.8
AOC 617
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
pH							
Ph	617001	6.27	6.18	6.47	NL	NL	NL
	617002	NI	4.95	6.55			

Notes:
MCL = Maximum Contaminant Level
NI = Not installed until April 1997
NL = Not listed
μg/L = Micrograms per liter
SMCL = Secondary Maximum Contaminant Level
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table*, January-June 1996 (USEPA 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA 1996e) were used as reference concentrations.
Bolded concentrations exceed both the RBC and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background values for groundwater are based on two sampling rounds in two wells at each depth
617002 (additional well) was sampled for the first time during the second quarter sampling event

Volatile Organic Compounds in Groundwater

No VOCs were detected in shallow groundwater at AOC 617.

Semivolatile Organic Compounds in Groundwater

One semivolatile organic compound was detected in groundwater below its RBC.

Inorganics Detected in Groundwater Samples

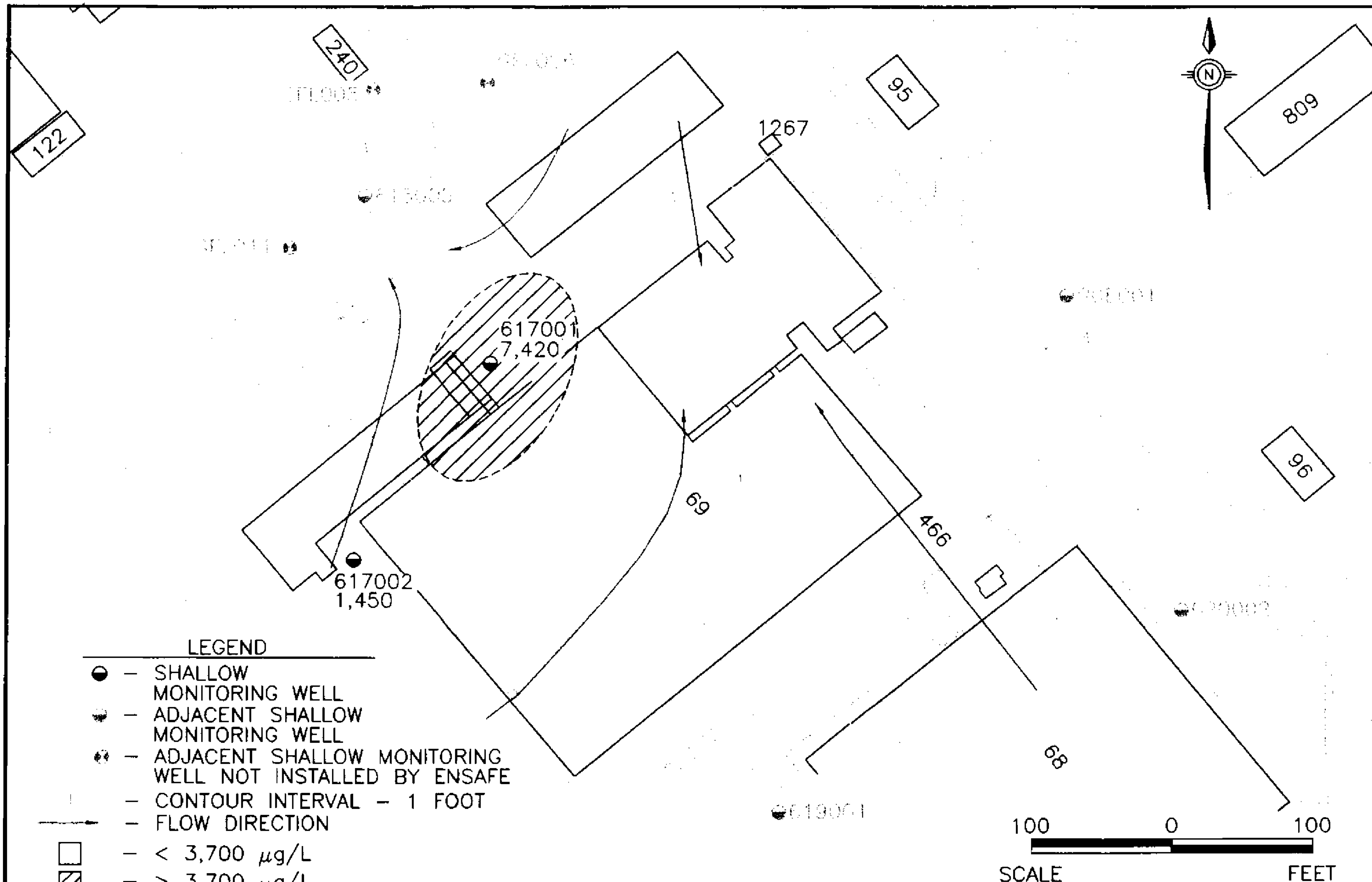
Nineteen metals were detected in AOC 617 groundwater samples. Aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc exceeded both their RBC and shallow groundwater background concentrations during the initial sampling. Figures 10.9-8 through 10.9-15 illustrate the distribution of these metals in shallow groundwater.

10.9.5 Fate and Transport Assessment for AOC 617

Environmental media sampled as part of the AOC 617 investigation include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for AOC 617 include soil-to-groundwater, groundwater-to-surface water, and emission of volatiles from surface soil to air.

10.9.5.1 Soil-to-Groundwater Cross-Medial Transport

Table 10.9.9 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to groundwater protection SSLs. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).



LEGEND

- SHALLOW MONITORING WELL
- ADJACENT SHALLOW MONITORING WELL
- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 1 FOOT
- FLOW DIRECTION
- < 3,700 μg/L
- > 3,700 μg/L
- APPROXIMATE EXTENT

NOTES:

- RESULTS IN μg/L
- 3,700 μg/L = TAP RBC FOR ALUMINUM (USEPA 1996b)

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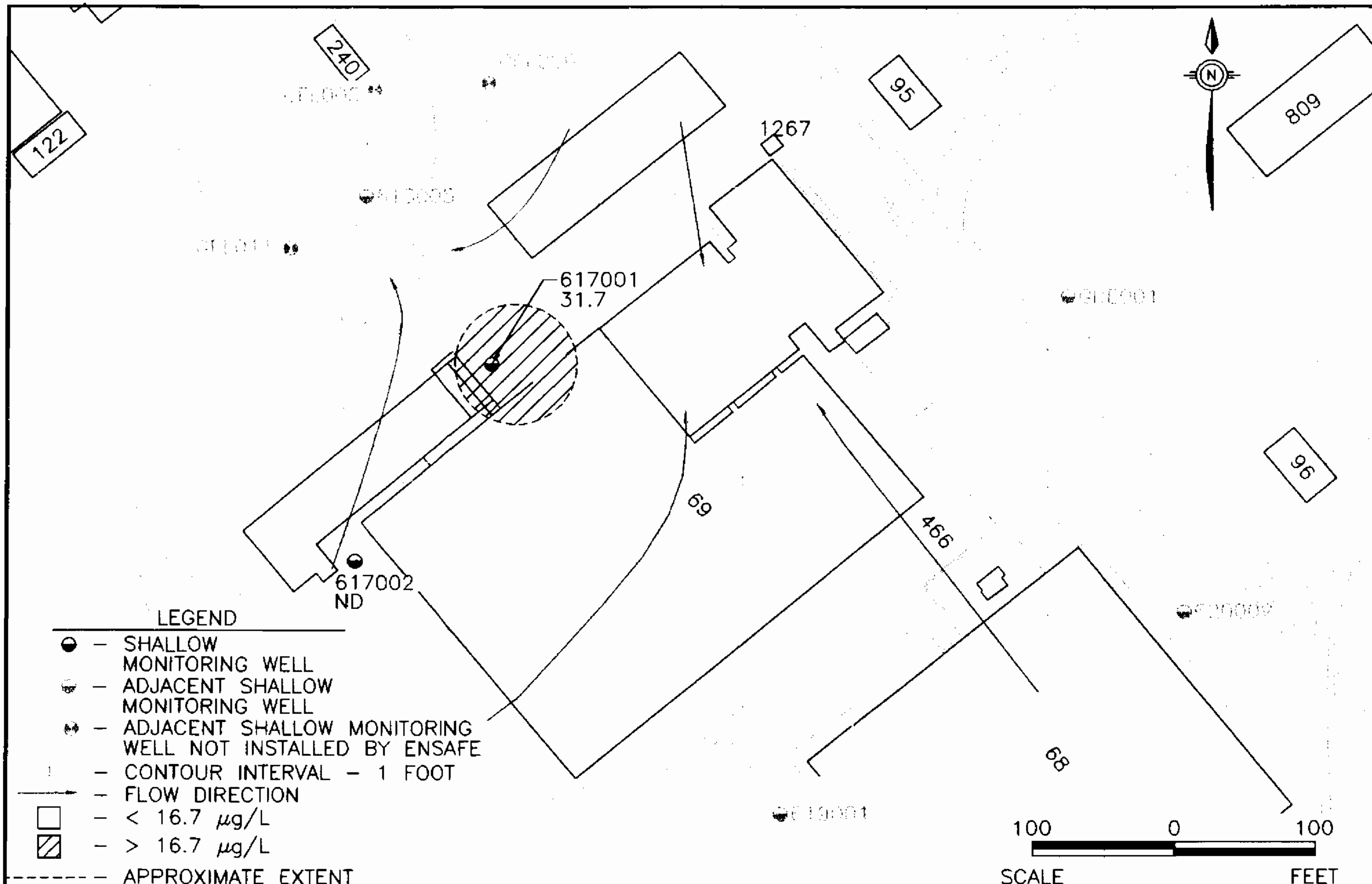
FIGURE 10.9–8
ALUMINUM IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97 | DWG NAME: 2906AISG



NOTES:
- RESULTS IN $\mu g/L$
- ND = NOT DETECTED
- 16.7 $\mu g/L$ = ZONE F BACKGROUND CONCENTRATION FOR ARSENIC IN SHALLOW GROUNDWATER

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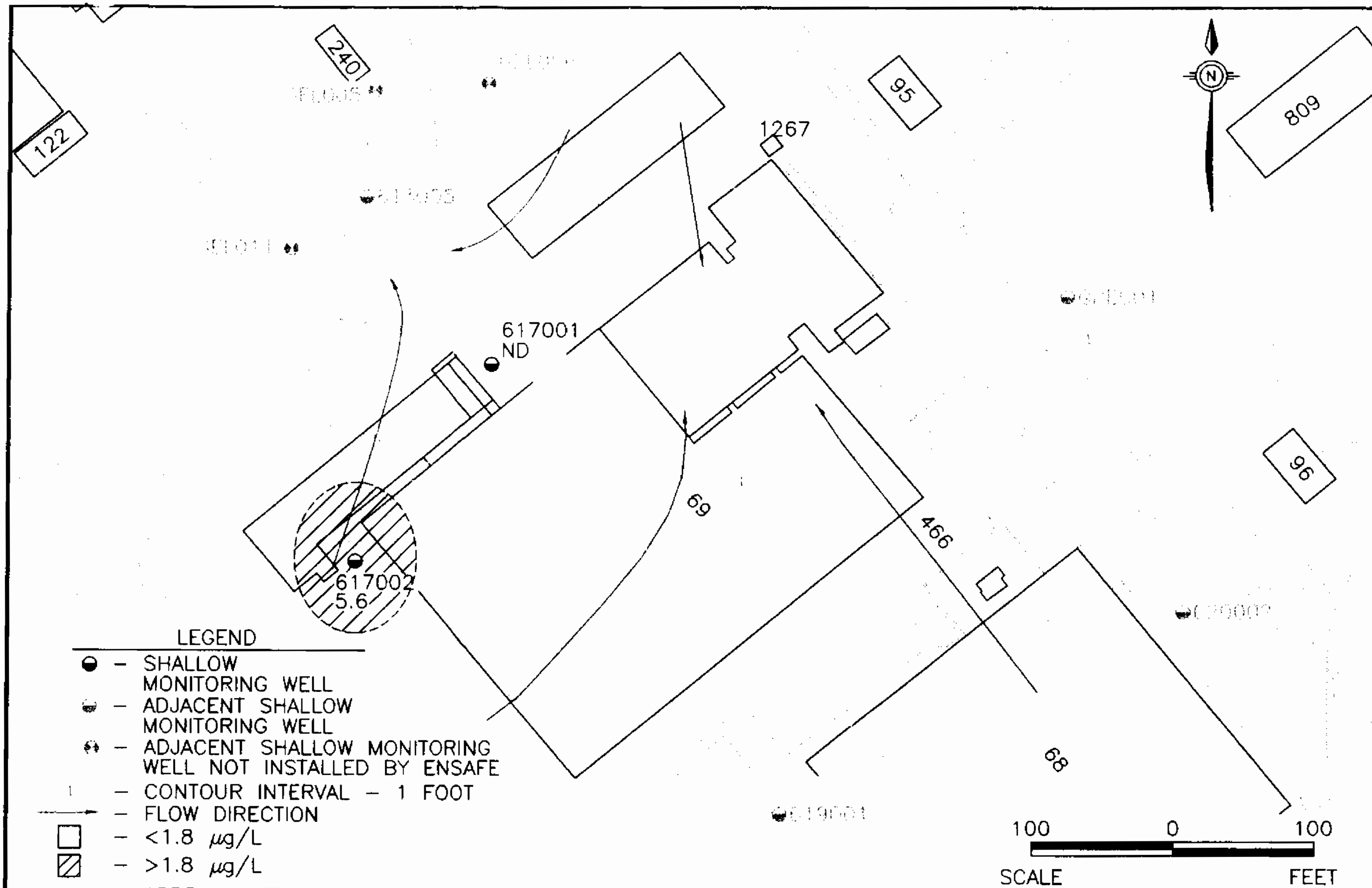
FIGURE 10.9–9
ARSENIC IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97 | DWG NAME: 2906ARSN



NOTES:
- RESULTS IN μg/L
- ND = NOT DETECTED
- 1.8 μg/L = TAP RBC FOR CADMIUM (USEPA 1996b)

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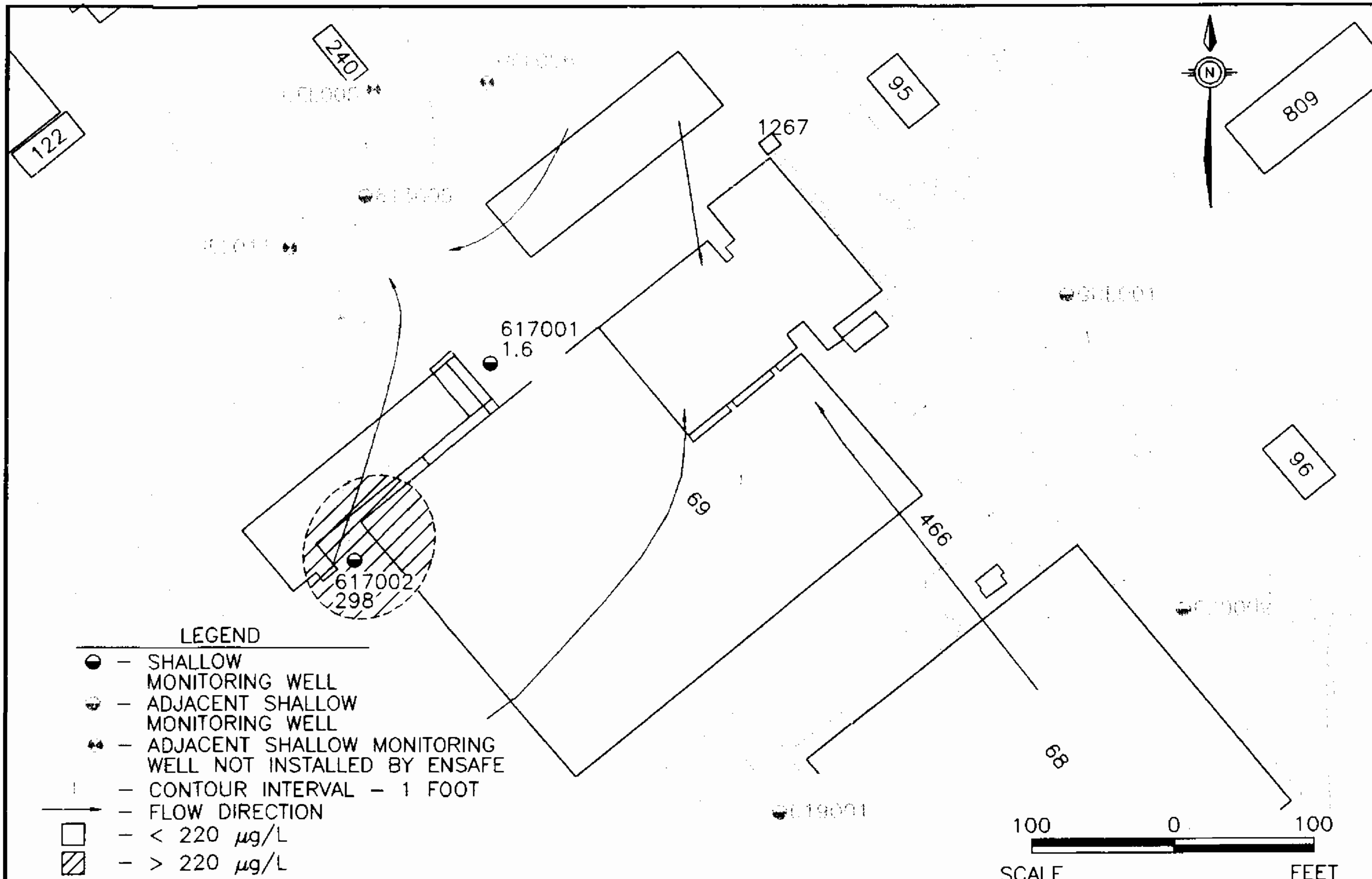
FIGURE 10.9–10
CADMIUM IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97 | DWG NAME: 2906CISG



LEGEND

- SHALLOW MONITORING WELL
- ADJACENT SHALLOW MONITORING WELL
- ADJACENT SHALLOW MONITORING WELL NOT INSTALLED BY ENSAFE
- CONTOUR INTERVAL – 1 FOOT
- FLOW DIRECTION
- < 220 µg/L
- > 220 µg/L
- APPROXIMATE EXTENT

NOTES:
- RESULTS IN µg/L
- ND = NOT DETECTED
- 220 µg/L = TAP RBC FOR COBALT (USEPA 1996b)

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FIGURE 10.9–11
COBALT IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97 | DWG NAME: 2906CBLT

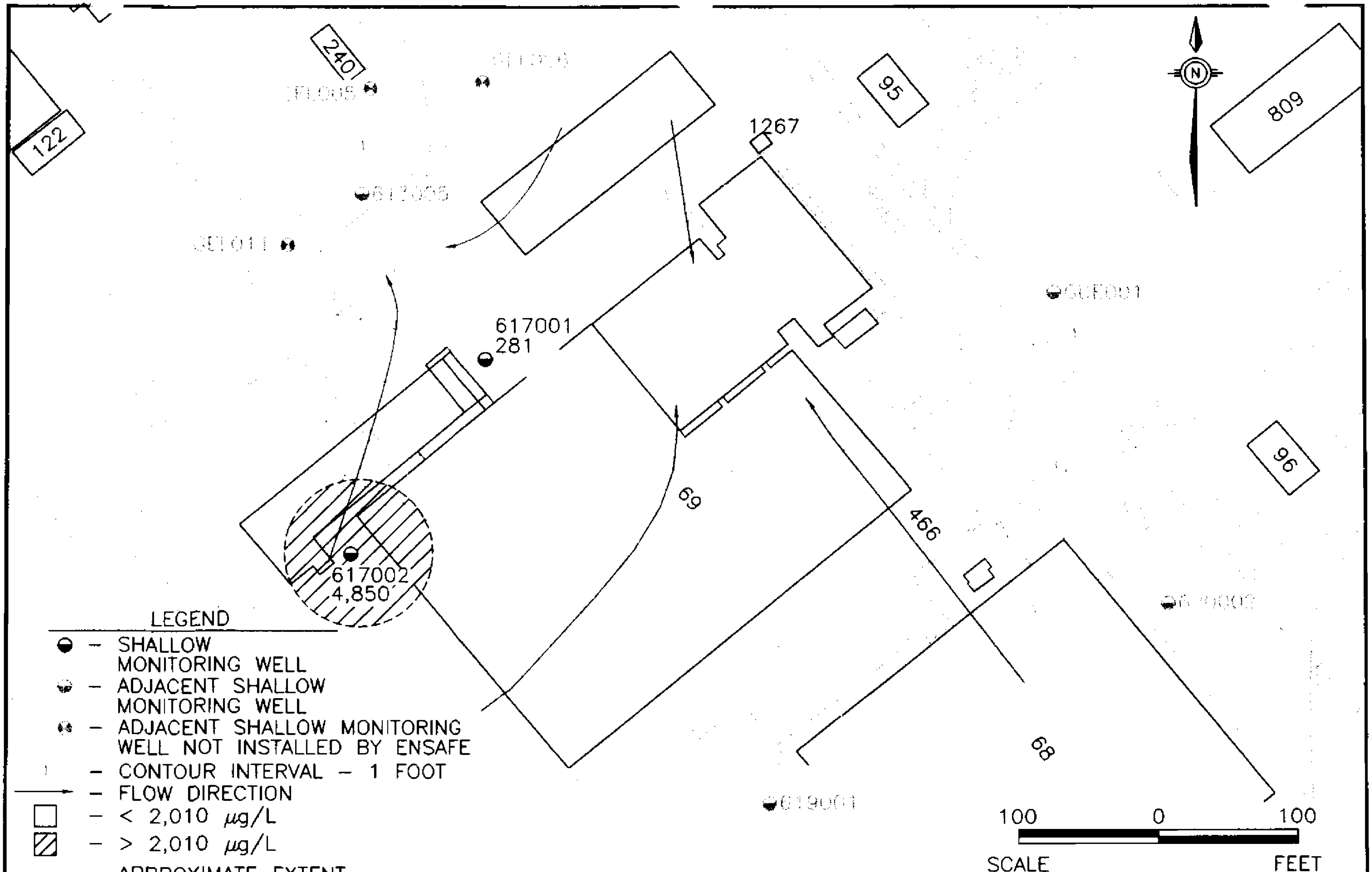

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FIGURE 10.9–12
MANGANESE IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97	DWG NAME: 2906MGSG

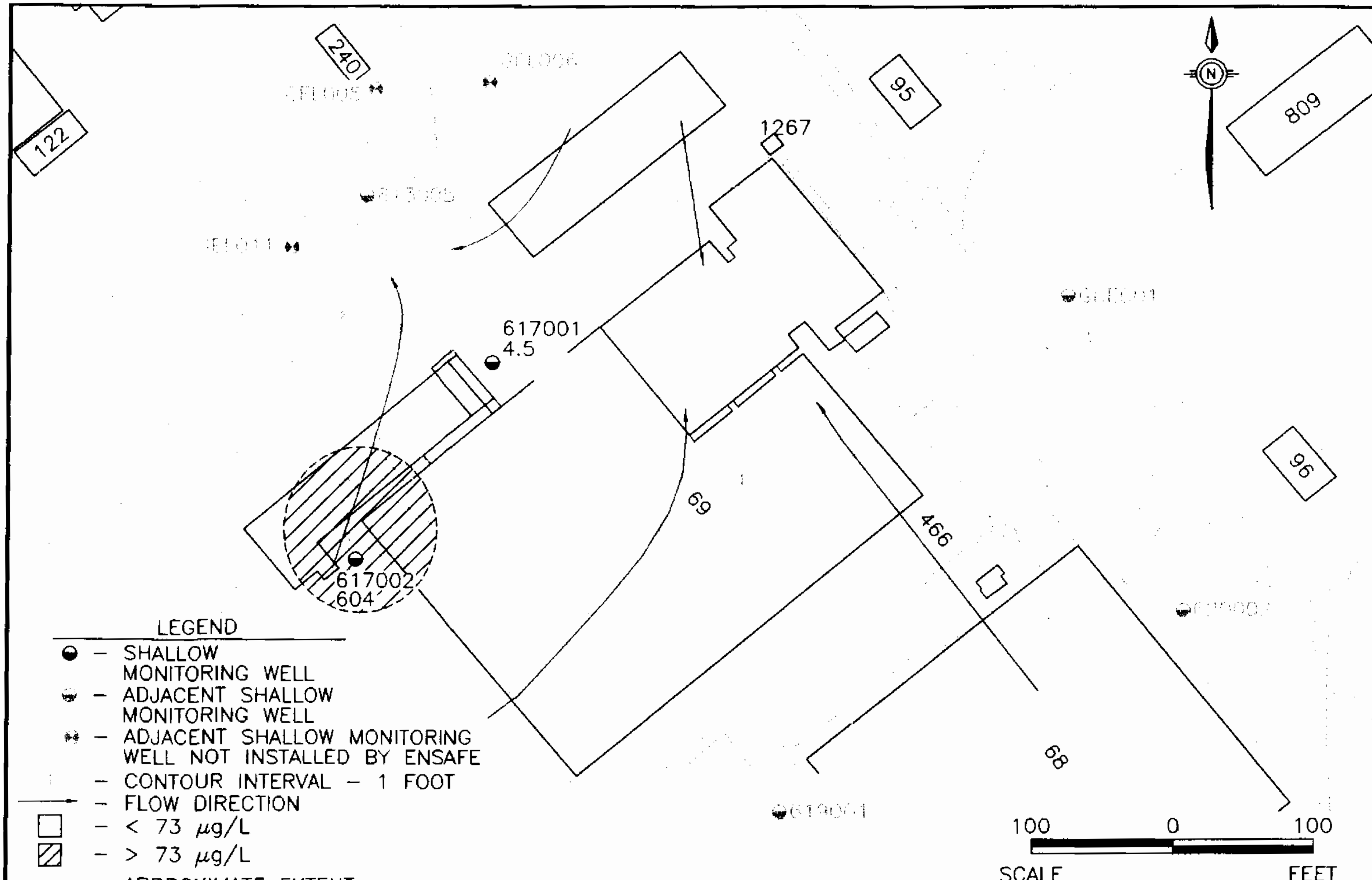

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FIGURE 10.9–13
NICKEL IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97 | DWG NAME: 2906NKSG

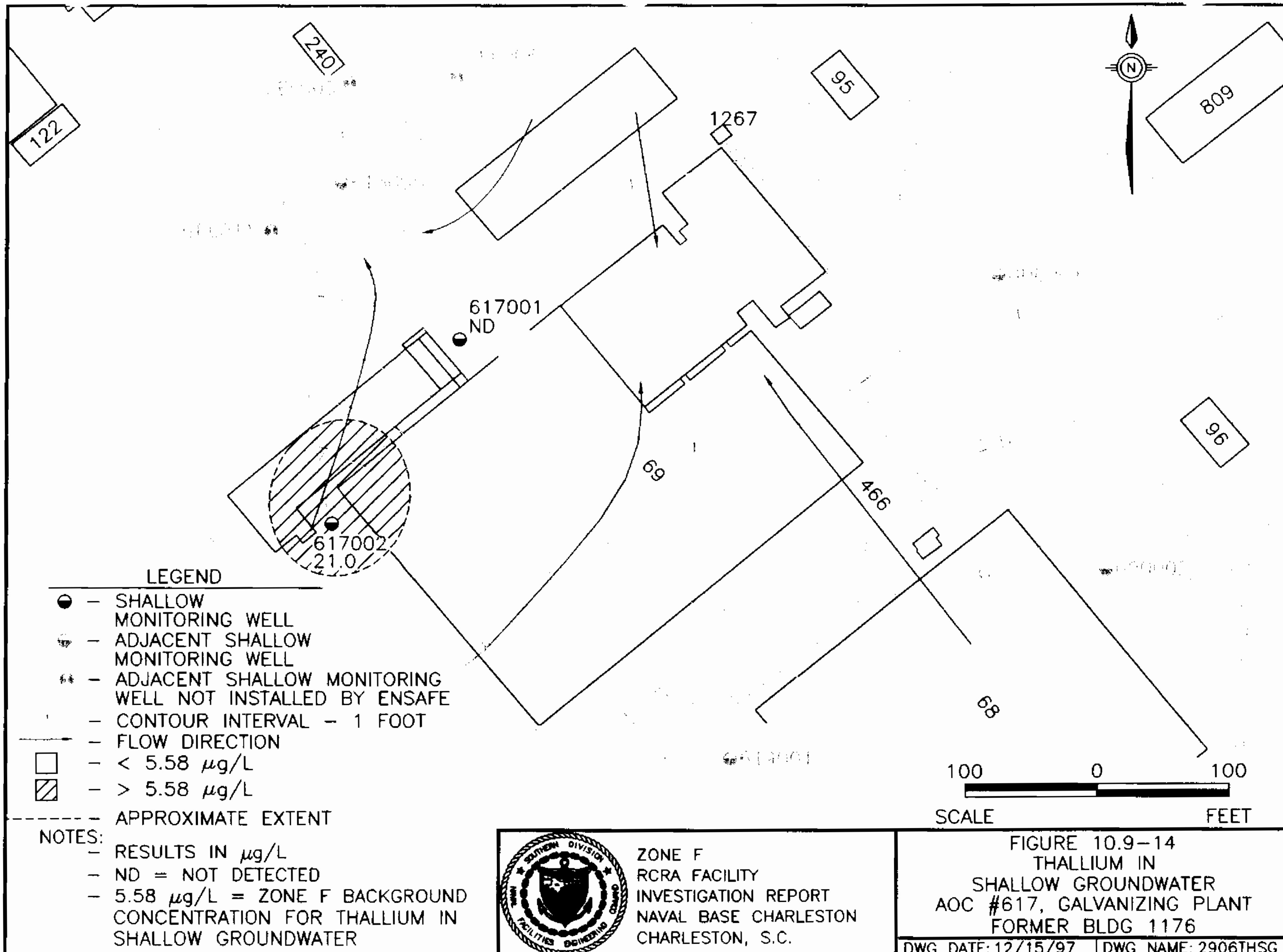

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FIGURE 10.9–14
THALLIUM IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/15/97 | DWG NAME: 2906THSG

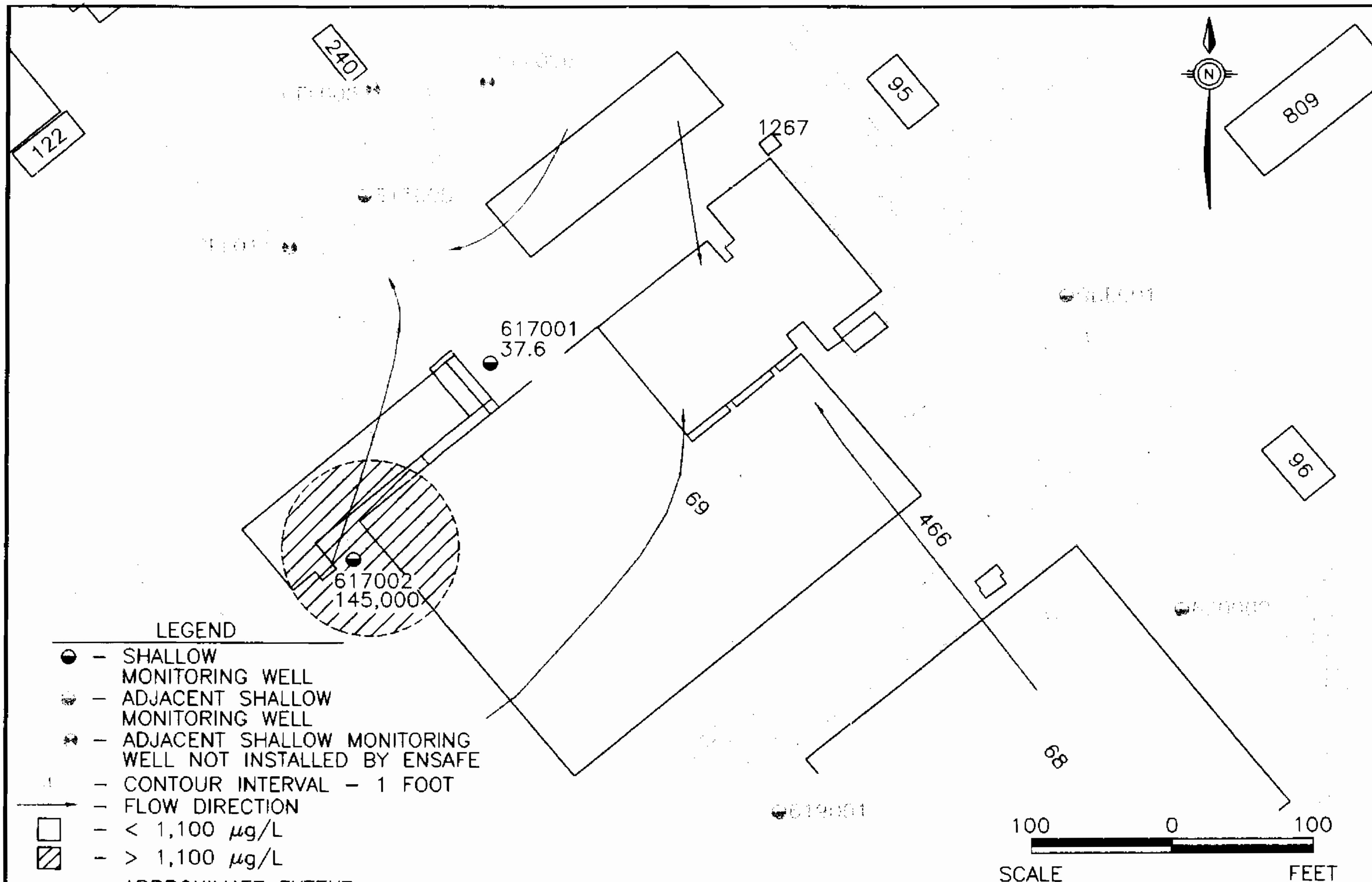

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FIGURE 10.9–15
ZINC IN
SHALLOW GROUNDWATER
AOC #617, GALVANIZING PLANT
FORMER BLDG 1176

DWG DATE: 12/10/97 | DWG NAME: 2906ZNCS

Table 10.9.9
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 617
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Carbon disulfide	ND	1	ND	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	2400	ND	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	40	4200	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	ND	130	ND	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	73	2800	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	130	5900	ND	NA	2000	0.092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	130	5500	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	82	3700	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	110	6200	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	150	6200	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	44	1600	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	78	2800	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	ND	ND	1	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	1200	ND	NA	240000	150	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	91	390	ND	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	220	14000	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	1900	ND	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	ND	280	ND	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	ND	870	ND	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	140	12000	ND	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	210	10000	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Aroclor-1260	ND	1700	NA	NA	1000	0.033	0.03	UG/KG	UG/L	YES	NO	NO
4,4'-DDD	4.3	4.45	NA	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	3	51	NA	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	ND	100	NA	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Herbicides												
2,4'-D	NA	160	NA	NA	3400	61	NA	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	NA	0.1812	NA	NA	1900	0.43	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	4580	15300	7420	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	ND	10.7	ND	NA	5	15	NA	MG/KG	UG/L	YES	NO	NO
Arsenic	2.6	15.5	31.7	NA	29	16.7	36	MG/KG	UG/L	NO	YES	NO
Barium	10.4	36.1	52.9	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.21	0.98	ND	NA	63	0.66	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.27	0.82	5.6	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	7.5	26	9.2	NA	38	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	3	6.4	298	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	4.1	33.2	ND	NA	920	1500	2.9	MG/KG	UG/L	NO	NO	NO
Cyanide	0.36	0.12	NA	NA	40	730	4.3	MG/KG	UG/L	NO	NO	NO
Lead	14.9	274	10.5	NA	400	15	8.5	MG/KG	UG/L	NO	NO	YES
Manganese	44.5	215	4850	NA	1100	2010	NA	MG/KG	UG/L	NO	YES	NO
Mercury	ND	1.5	0.18	NA	2	11	0.025	MG/KG	UG/L	NO	NO	YES
Nickel	3.3	44	604	NA	130	730	61.1	MG/KG	UG/L	NO	NO	YES
Selenium	0.61	0.89	6.5	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Thallium	0.39	ND	21	NA	1.24	2.9	21.3	MG/KG	UG/L	NO	YES	NO
Tin	ND	33.9	ND	NA	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	8.6	49.2	18.6	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO

Table 10.9.9
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Salt Water Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone F: AOC 617
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurfac Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Zinc	284	316	145000	NA	12000	11000	86	MG/KG	UG/L	NO	YES	YES

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, June 3, 1996
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background reference value.

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
GW - Groundwater
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

No organic constituents were detected in AOC 617 surface soil at concentrations exceeding groundwater protection SSLs. One semivolatile, benzo(a)anthracene, and one PCB, Aroclor-1260, were detected in subsurface soil at concentrations exceeding SSLs. These exceedances were limited to locations 617SB003 and 617SB004. Notably, the majority of organic analytes exhibited significant enrichment in concentration with depth in the soil column. The source of these organics is unclear; their distribution is inconsistent with a surficial source unless their mobility has been enhanced through some source activity, such as a release of a mobilizing agent. Such a release could produce the characteristic profile of increasing concentration as a function of depth. In theory, these compounds present a potential threat to groundwater; the empirical data suggest otherwise, or at least that the potential for leaching is minimal, as they were not detected in site groundwater.

No inorganic constituents were detected above applicable SSLs in surface soil. One inorganic, antimony, was detected in subsurface soil at concentrations above its SSL and background values. Similar to the organics distribution, these exceedances were limited to locations 617SB003 and 617SB004. Also consistent with the organics distribution, most inorganic species exhibited significant enrichment with depth. The nature of the inorganics distribution, particularly vertically within the soil column, strongly imply association with surficial release of a mobilizing agent. In this case, the site history clearly provides that possibility via release of zinc solutions and inorganic acid solutions. Overall, however, the occurrence of both inorganic and organic exceedances does not cover a large area horizontally. Additionally, groundwater data suggest that leaching of these constituents at or above deleterious effects levels is not occurring.

10.9.5.2 Groundwater-to-Surface Water Cross-Media Transport

Table 10.9.9 also compares maximum detected organic constituent concentrations in shallow groundwater samples to RBCs for tap water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) tap water RBCs, or (b) background concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No organic compounds were detected in groundwater above applicable screening levels. Four inorganics — arsenic, manganese, thallium, and zinc — were detected in first quarter samples at concentrations exceeding their respective RBC values. Of these, arsenic was limited to well 617001, and the others were detected at well 617002. Additionally, only arsenic remained above its RBC by the third quarter sampling, and that exceedance was slight. Four inorganics-lead, mercury, nickel, and zinc — were present in first quarter samples above the saltwater screening criteria. Lead exceeded the criteria at well 617001, nickel and zinc exceeded the criteria at well 617002, and mercury exceeded the criteria in samples from both wells. By the third quarter, only the mercury concentration remained above the saltwater screening criteria. Given that site activities were terminated in 1985, this trend could reflect a dynamic flux of constituents into the aquifer, influenced by climatological factors, or more likely, reflect more representative samples collected from an increasingly developed well. With regard to RBC exceedances, groundwater under the site is not used as a potable resource, nor are there future plans or reasons to develop the aquifer for such use. Therefore, the migration pathway is invalid due to an incomplete exposure pathway. With regard to surface water discharge, the nearest water body is the Cooper River, approximately 900 feet to the northwest. Site vicinity groundwater flow is characterized by a flow convergence from the north and southwest (just north of the AOC), with the trough of the convergence directed to the west. Consequently, it is improbable that this groundwater will discharge to the Cooper River, and the migration pathway is therefore invalid.

10.9.5.3 Soil-to-Air Cross-Media Transport

Table 10.9.9 lists the VOCs detected in surface soil samples collected at AOC 617. No volatiles were detected in site surface soil and therefore the migration pathway is invalid.

10.9.5.4 Fate and Transport Summary

Constituents present above leachability-based SSLs were limited to two organic and one inorganic and were limited to two soil sample locations. However, both organics and inorganics exhibited significant enrichment as a function of depth in the soil column, implying enhanced mobility potentially related to past site activities. No organic compounds were present in groundwater above screening levels, but first quarter groundwater samples showed four inorganics that exceeded applicable RBCs and four that exceeded the applicable saltwater surface water chronic criteria. Subsequent sampling during two additional quarters exhibited a decrease in these exceedances; during the third quarter, only arsenic remained above its RBC, and only mercury remained above its saltwater criteria. No VOCs present in site soil were detected above soil-to-air screening values.

Empirical groundwater data indicate that the soil-to-groundwater pathway is insignificant at this AOC. As for groundwater migration, attenuation of initial inorganic exceedances certainly diminishes the importance of this pathway at AOC 617; additionally, the surficial groundwater pathway for risk-based exposure is invalid due to the non-use of the shallow groundwater. The nearest surface water is a significant distance away and is inconsistent with groundwater flow direction from the site, and is therefore not considered significant with respect to this AOC. The soil-to-air volatilization pathway at this AOC is unsubstantiated by the data and is considered insignificant.

10.9.6 Human Health Risk Assessment for AOC 617

10.9.6.1 Site Background and Investigative Approach

AOC 617 was a former galvanizing plant at Building 1176, which was in operation until about 1985. The building has since been demolished and Building 69, a shipping and supply center was constructed in the general area. A 3,000 gallon UST apparently was used for onsite chemical storage. Materials released, stored or disposed of at the site included zinc solutions and inorganic acids.

During the RFI, a total of eight soil samples were collected from four locations. Both upper and lower intervals were collected to identify potential impacts resulting from the activities listed above. Surface soil data was used to quantitatively assess soil exposure pathways. Two monitoring wells were installed in the shallow aquifer. Data from the initial sampling event for each well were used to quantitatively assess groundwater exposure pathways. Sections 10.9.3 and 10.9.4 provide summaries of the sampling effort for AOC 617 soil and groundwater.

10.9.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.9.10, BEQs were the only COPCs identified in surface soil. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

Groundwater

As shown in Table 10.9.11, aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc were identified as COPCs in shallow groundwater for AOC 617, by exceeding their

Table 10.9.10
Chemicals Present in Site Samples
AOC 617 - Surface Soils
Naval Base Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Reference	Units	Number Exceeding RBC	Ref
Carcinogenic PAHs													
B(a)P Equiv.	*	2	4	67.8	204.3	136.0	404	428	88	NA	UG/KG	1	
Benzo(a)anthracene		2	4	44	130	87	175	185	880	NA	UG/KG		
Benzo(a)pyrene	*	2	4	56	130	93	175	185	88	NA	UG/KG	1	
Benzo(b)fluoranthene		2	4	69	82	75.5	175	185	880	NA	UG/KG		
Benzo(k)fluoranthene		2	4	47	110	78.5	175	185	8800	NA	UG/KG		
Chrysene		2	4	54	150	102	175	185	88000	NA	UG/KG		
Dibenz(a,h)anthracene		1	4	44	44	44	175	185	88	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		1	4	78	78	78	175	185	880	NA	UG/KG		
Inorganics													
Aluminum (Al)		4	4	3890	4580	4213	NA	NA	7800	18500	MG/KG		
Arsenic (As)		4	4	0.97	2.6	1.67	NA	NA	0.43	19.9	MG/KG	4	
Barium (Ba)		4	4	3.4	10.4	7.28	NA	NA	550	61.5	MG/KG		
Beryllium (Be)		4	4	0.11	0.21	0.16	NA	NA	0.15	1.05	MG/KG	2	
Cadmium (Cd)		2	4	0.15	0.27	0.21	0.02	0.02	3.9	0.26	MG/KG		1
Calcium (Ca)	N	4	4	924	25100	8981	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		4	4	4.1	7.5	5.8	NA	NA	39	34.8	MG/KG		
Cobalt (Co)		4	4	0.57	3	1.34	NA	NA	470	15.1	MG/KG		
Copper (Cu)		2	4	4	4.1	4.05	0.48	0.5	310	48.2	MG/KG		
Cyanide (CN)		3	3	0.16	0.36	0.29	NA	NA	160	0.29	MG/KG		2
Iron (Fe)	N	4	4	1580	3830	2715	NA	NA	NA	NA	MG/KG		
Lead (Pb)		2	4	11.2	14.9	13.05	0.9	1.05	400	180	MG/KG		
Magnesium (Mg)	N	4	4	213	689	372	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		4	4	9.5	44.5	19.7	NA	NA	180	307	MG/KG		
Nickel (Ni)		4	4	1.1	3.3	2.1	NA	NA	160	12.6	MG/KG		
Potassium (K)	N	4	4	110	214	150	NA	NA	NA	NA	MG/KG		
Selenium (Se)		2	4	0.42	0.61	0.52	0.16	0.16	39	1.15	MG/KG		
Sodium (Na)	N	4	4	138	203	174	NA	NA	NA	NA	MG/KG		
Thallium (Tl)		1	4	0.39	0.39	0.39	0.18	0.19	0.63	NA	MG/KG		
Vanadium (V)		4	4	3.5	8.6	6.38	NA	NA	55	48.9	MG/KG		
Zinc (Zn)		3	4	24.5	284	116	2.1	2.1	2300	198	MG/KG		1
Pesticides													
4,4'-DDD		1	3	4.3	4.3	4.3	1.3	1.4	2700	NA	UG/KG		
4,4'-DDE		1	3	3	3	3	1.3	1.4	1900	NA	UG/KG		
Semivolatile Organics													
Anthracene		1	4	40	40	40	175	185	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		1	4	73	73	73	175	185	310000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate		1	4	91	91	91	175	185	46000	NA	UG/KG		
Fluoranthene		2	4	84	220	152	175	185	310000	NA	UG/KG		
Phenanthrene		2	4	58	140	99	175	185	310000	NA	UG/KG		
Pyrene		2	4	69	210	139.5	175	185	230000	NA	UG/KG		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available
N - Essential nutrient

Table 10.9.11
Chemicals Present in Site Samples
AOC 617 - Shallow Groundwater
Naval Base Charleston, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Reference	Units	Number Exceeding RBC	Ref
Inorganics													
Aluminum (Al)	*	2	2	1450	7420	4435	NA	NA	3700	224	UG/L	1	2
Arsenic (As)	*	1	2	31.7	31.7	31.7	1.05	1.05	0.045	16.7	UG/L	1	1
Barium (Ba)		1	2	52.9	52.9	52.9	6.25	6.25	260	94.3	UG/L		
Cadmium (Cd)	*	1	2	5.6	5.6	5.6	0.25	0.25	1.8	0.82	UG/L	2	1
Calcium (Ca)	N	2	2	20300	441000	230650	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	2	9.2	9.2	9.2	0.5	0.5	18	2.05	UG/L		1
Cobalt (Co)	*	2	2	1.6	298	149.8	NA	NA	220	10.9	UG/L	1	1
Iron (Fe)	N	2	2	16700	314000	165350	NA	NA	NA	NA	UG/L		
Lead (Pb)		1	2	10.5	10.5	10.5	1.1	1.1	15	NA	UG/L		
Magnesium (Mg)	N	2	2	4170	225000	114585	NA	NA	NA	NA	UG/L		
Manganese (Mn)	*	2	2	281	4850	2565.5	NA	NA	84	2010	UG/L	2	1
Mercury (Hg)		1	2	0.18	0.18	0.18	0.05	0.05	1.1	NA	UG/L		
Nickel (Ni)	*	2	2	4.5	604	304.25	NA	NA	73	5.55	UG/L	1	1
Potassium (K)	N	2	2	3620	3660	3640	NA	NA	NA	NA	UG/L		
Selenium (Se)		2	2	4.9	6.5	5.7	NA	NA	18	NA	UG/L		
Sodium (Na)	N	2	2	179000	866000	522500	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	1	2	21	21	21	1.35	1.35	0.29	5.58	UG/L	1	1
Vanadium (V)		1	2	18.6	18.6	18.6	0.55	0.55	26	1.58	UG/L		1
Zinc (Zn)	*	2	2	37.6	145000	72518.8	NA	NA	1100	NA	UG/L	1	
Semivolatile Organic													
Butylbenzylphthalate		1	2	1	1	1	5	5	730	NA	UG/L		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/L - micrograms per liter
NA - Not applicable or not available
N - Essential nutrient

corresponding RBCs and background concentrations. An insufficient number of groundwater background samples were collected to run Wilcoxon rank sum test analyses; therefore these analyses were not performed for Zone F. Risk and hazard associated with background concentrations are discussed in the uncertainty section.

10.9.6.3 Exposure Assessment

Exposure Setting

AOC 617 is in a highly industrialized setting, approximately 900 feet southwest of the waterfront along the Cooper River. The site is mostly surrounded by buildings and roads, railroad right-of-ways and mostly paved storage/parking areas. The site is covered with asphalt, concrete or a building which would prevent direct contact with soil and inhibit migration of potential contaminants to groundwater or air. All potable water is provided through the city's water supply. Shallow groundwater at the site is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered to be protective of current site users. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for current and future site workers are the same as those for the future site resident with respect to soil. The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater. No VOCs were reported in first-quarter groundwater samples at AOC 617, therefore the inhalation of volatiles pathway was not addressed for this site. Uniform exposure was assumed for all sample locations. Table 10.9.12 presents the justification for exposure pathways assessed in this HHRA.

Table 10.9.12
Exposure Pathways Summary — AOC 617
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	No surface soil is exposed at AOC 617, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or process water at AOC 617.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or process water at AOC 617.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be representative of current receptors.

Table 10.9.12
Exposure Pathways Summary — AOC 617
NAVBASE — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 617, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or process water at AOC 617, however, this pathway was considered as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

Since less than ten samples were collected in surface soil and groundwater, maximum detected concentrations were used as EPCs, as discussed in Section 7 of this RFI.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.9.13 and 10.9.14, respectively.

Groundwater

The CDIs for groundwater ingestion are presented in Table 10.9.15.

10.9.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.9.16 presents toxicological information specific to each COPC identified at AOC 617. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Aluminum is one of the most abundant metals in the earth's crust (7% aluminum), and it is ubiquitous in air and water, as well as soil. This metal is water-soluble, silvery, and ductile, which suggests its usefulness in many processes. Ingesting aluminum can affect the absorption of other elements within the gastrointestinal tract and can alter intestinal function. Aluminum can potentially interfere with the absorption of essential nutrients and cholesterol. Another effect on the gastrointestinal system is the inhibition of acetylcholine-induced contractions, which are part of the neuro-muscular system controlling bowel muscles. The effect could explain why aluminum-containing antacids often produce constipation and indicates aluminum could affect the uptake of other chemicals. Aluminum dust is moderately flammable and explosive in heat. Inhaling this dust can cause fibrosis (aluminosis) (Klaassen, et al., 1986; Dreisbach et al., 1987). No data are available on an applicable SF or the USEPA cancer group. The USEPA Region IV Office of Health Assessment suggested using the provisional oral RfD of 1.0 mg/kg-day. The aesthetic-based SMCL for drinking water is 50 to 200 μg/L.

Table 10.9.13
Chronic Daily Intakes (CDI)
Incidental Ingestion of Surface Soil
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Semivolatile Organic Compounds							
Benzo(a)pyrene equivalents	1	0.20	2.8E-07	2.6E-06	3.2E-07	1.0E-07	3.6E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.9.14
Chronic Daily Intakes (CDI)
Dermal Contact with Surface Soil
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	1	0.20	0.01	1.1E-07	3.8E-07	7.2E-08	8.2E-08	2.9E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.9.15
Chronic Daily Intakes (CDI)
Ingestion of COPCs in Shallow Groundwater
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Aluminum (Al)	7.42	2.03E-01	4.74E-01	1.12E-01	7.26E-02	3.57E-02
Arsenic (As)	0.032	8.77E-04	2.05E-03	4.82E-04	3.13E-04	1.54E-04
Cadmium (Cd)	0.0056	1.53E-04	3.58E-04	8.44E-05	5.48E-05	2.70E-05
Cobalt (Co)	0.298	8.16E-03	1.91E-02	4.49E-03	2.92E-03	1.43E-03
Manganese (Mn)	4.85	1.33E-01	3.10E-01	7.31E-02	4.75E-02	2.33E-02
Nickel (Ni)	0.604	1.65E-02	3.86E-02	9.10E-03	5.91E-03	2.91E-03
Thallium (Tl)	0.021	5.75E-04	1.34E-03	3.16E-04	2.05E-04	1.01E-04
Zinc (Zn)	145	3.97E+00	9.27E+00	2.18E+00	1.42E+00	6.98E-01

NOTES:

lwa lifetime weighted average
CDI Chronic Daily Intake
H-CDI Non-carcinogenic hazard based Chronic Daily Intake

Table 10.9.16
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
nical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
iinum	1	b	NA	NA	NA	NA		NA	NA	NA	NA		NA		NA	NA
iic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
o(a)pyrene Equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	6.1	c	B2	mutagen
iium (food)	0.001	a	H	proteinuria	10	NA		NA	NA	NA	NA		6.3	a	B1	lung
iium (water)	0.0005	a	H	proteinuria	10	NA		NA	NA	NA	NA		6.3	a	B1	lung
lt	0.06	b	NA	NA	NA	NA		NA	NA	NA	NA		NA		NA	NA
;anese (food)	0.047	a	NA	neurological effects	1	NA		NA	NA	NA	NA		NA		D	NA
;anese (water)	0.023	a	NA	neurological effects	1	1.43E-05	a	M	neurological effects	1000	NA		NA		D	NA
:l	0.02	a	M	decreased body and organ weight	300	NA		NA	NA	NA	NA		NA		D	NA
ium	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA		NA		D	NA
	0.3	a	M	decreased enzyme levels	3	NA		NA	NA	NA	NA		NA		D	NA

NOTES:

a = Integrated Risk Information System (IRIS)
b = EPA NCEA - Cincinnati (provisional)
c = Withdrawn from IRIS/HEAST
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. As listed in IRIS the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium-containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system (Klaassen et al., 1986). An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. As listed in IRIS, the classification is based on limited evidence from occupational epidemiologic studies consistent across investigations and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven rat and mice studies where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. As listed in IRIS, the critical effect of this chemical in water is significant proteinuria. The uncertainty factor was 10 and the modifying factor was 1. The critical effect of this chemical in food is human studies involving chronic exposures. The uncertainty factor was 10 and the modifying factor was 1.

Cobalt is an essential nutrient necessary for enzyme metabolism and for the production of red blood cells. It has been determined that there are approximately 0.0434 μg cobalt per μg vitamin B_{12}. The RDA for vitamin B_{12} is 6 μg, which would result in an RDA of 0.26 μg for cobalt (as is contained in typical vitamin supplements). Chronic ingestion of cobalt has been associated with goiter, and alcohol is thought to potentiate other toxic effects of this element. Cobalt was historically added to beer to enhance its foaming qualities; this has led to cardiomyopathy (i.e., irregular heart muscle actions). In toxic doses, cobalt produces vomiting, diarrhea, and a sensation of warmth. Other signs of cobalt toxicity are increased blood pressure, flushing of the face, giddiness, tinnitus, and deafness due to nerve damage. USEPA determined that the RfDo for this essential element is 0.06 mg/kg-day (Klaassen, et al., 1986).

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children

(Klaassen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from soil and water. In addition, the body is roughly twice as efficient absorbing manganese in water compared to manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA – one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

Nickel is also an essential nutrient; a five microgram dose is typical of supplemental vitamins. USEPA set the RfDo to 0.02 mg/kg-day. Chronic exposure of rats to nickel caused decreased body and organ weights. For a chronically exposed individual, nickel salts would affect the gastro-intestinal system, and would also target the liver and kidney. This element has been shown to be a sensitizer, an element that can produce allergic reactions. Sensitization of skin to nickel dust has been shown to occur in industry (Dreisbach, et al., 1987).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's RfDo for thallium is 0.00008 mg/kg-day (Klaassen, et al., 1986; Dreisbach, et al., 1987).

Zinc is an essential, ubiquitous element present in food, water, and soil. The average American daily intake is approximately 12 to 15 mg, and the recommended daily allowance is 15 mg. Excessive exposure to zinc is relatively uncommon and requires exposure to high concentrations. This element does not accumulate under chronic exposure conditions, and body content is self-regulated by zinc liver concentrations and absorption mechanisms. Inhaling zinc dust can cause metal fume fever, and the primary effect of zinc ingestion (at toxic concentrations) is gastrointestinal disturbance and irritation. Other effects on the blood, liver, and kidney are possible at higher concentrations. Twelve grams of elemental zinc per day were not shown to elicit effects other than gastrointestinal disturbances over 48 hours. Experimental animals have been given 100 times the dietary requirements without discernible effects. USEPA determined that the RfDo is 0.3 mg/kg-day (Klaassen et al., 1986).

BEQs include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified (see Additional Comments for Oral Exposure). This section provides information on three aspects of the carcinogenic risk assessment for the agent in question: the USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

As listed in IRIS, the basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. As listed in IRIS, the basis for the benzo(a)anthracene B2 classification is no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. As listed in IRIS, the basis for the benzo(k)fluoranthene B2 classification is no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

10.9.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.9.17 and 10.9.18 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Table 10.9.17
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Semivolatile Organic Compounds							
Benzo(a)pyrene equivalents	NA	7.3	ND	ND	2.3E-06	ND	2.6E-07
SUM Hazard Index/ILCR			NA	NA	2E-06	NA	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.9.18
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Semivolatile Organic Compounds								
Benzo(a)pyrene equivalents	0.5	NA	14.6	ND	ND	1.0E-06	ND	4.3E-07
SUM Hazard Index/ILCR				NA	NA	1E-06	NA	4E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 617 surface soils is 2E-06. The dermal pathway ILCR is 1E-06. BEQs were the sole contributors to the ingestion and dermal pathways.

Hypothetical Site Workers

Site worker ILCRs are 3E-07 and 4E-07 for the ingestion and dermal contact pathways, respectively. BEQs were the sole contributors for each pathway.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under a residential scenario based on the results of the first quarter sampling event. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.9.19 presents the risk and hazard for the ingestion pathway. Since no VOCs were identified as COPCs in groundwater at AOC 617, the inhalation pathway was not addressed at this site.

Hypothetical Site Residents

The ingestion ILCR for AOC 617 shallow groundwater (based on the adult and child lifetime weighted average) is 7E-04, with arsenic as the sole contributor to ILCR projections. The HIs for the adult and child resident are 31 and 71, respectively. Arsenic, manganese, thallium, and zinc were the primary contributors to HIs. Aluminum, cadmium, cobalt, and nickel were secondary contributors.

Table 10.9.19
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Aluminum (Al)	1	NA	0.20	0.47	NA	0.073	NA
Arsenic (As)	0.0003	1.5	2.9	6.8	7.2E-04	1.0	2.3E-04
Cadmium (Cd)	0.0005	NA	0.31	0.72	NA	0.11	NA
Cobalt (Co)	0.06	NA	0.14	0.32	NA	0.049	NA
Manganese (Mn)	0.023	NA	5.8	13.5	NA	2.1	NA
Nickel (Ni)	0.02	NA	0.83	1.9	NA	0.30	NA
Thallium (Tl)	0.00008	NA	7.2	17	NA	2.6	NA
Zinc (Zn)	0.3	NA	13	31	NA	4.7	NA
SUM Hazard Index/ILCR			31	71	7E-04	11	2E-04

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime excess Cancer Risk
- The one-hit equation for high carcinogenic risk levels was used for 3,3-Dimethylbenzidine resident lwa ILCR calculations

Hypothetical Site Workers

The ingestion ILCR for AOC 617 shallow groundwater is 2E-04, with arsenic as the sole contributor to ILCR projections. The HI for the site worker is 11. Arsenic, manganese, thallium, and zinc were the primary contributors to HIs; while aluminum, cadmium, cobalt, and nickel were secondary contributors.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 617 or other areas of Zone F. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. Table 10.9.20 presents the COCs identified for AOC 617 surface soil and shallow groundwater.

Table 10.9.20
Summary of Risk and Hazard-based COCs
AOC 617
NAVBASE - Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs			
Surface Soil	Incidental Ingestion	**Semivolatile Organic Compounds**									
		Benzo(a)pyrene equivalents	ND	ND	2.3E-06	ND	2.6E-07		2		
	Dermal	**Semivolatile Organic Compounds**									
		Benzo(a)pyrene equivalents	ND	ND	1.0E-06	ND	4.3E-07		2		
Surface Soil Pathway Sum			NA	NA	3E-06	NA	7E-07				
Groundwater	Ingestion	**Inorganics**									
		Aluminum (Al)	0.20	0.47	NA	0.073	NA	1			
		Arsenic (As)	2.9	6.8	7.2E-04	1.0	2.3E-04	1	2	3	4
		Cadmium (Cd)	0.31	0.72	NA	0.11	NA	1		3	
		Cobalt (Co)	0.14	0.32	NA	0.049	NA	1			
		Manganese (Mn)	5.8	13.5	NA	2.1	NA	1		3	
		Nickel (Ni)	0.83	1.9	NA	0.30	NA	1		3	
		Thallium (Tl)	7.2	16.8	NA	2.6	NA	1		3	
		Zinc (Zn)	13.2	30.9	NA	4.7	NA	1		3	
Groundwater Pathway Sum			31	71	7E-04	11	2E-04				
Sum of All Pathways			31	71	7E-04	11	2E-04				

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Future Site Residents

BEQs were identified as the soil pathway COCs based on their contribution to cumulative ILCR projections.

Future Site Workers

No soil pathway COCs were identified for the future industrial scenario.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential soil RBCs were compared to each reported concentration for BEQs. BEQs were detected above the residential RBC in one of four surface soil samples collected for AOC 617. Elevated benzo(a)pyrene equivalent concentrations were identified in surface soil sample 617SB004, otherwise low-level BEQs tend to be distributed across the site.

First Quarter Groundwater

Future Site Residents

Arsenic was identified as the only groundwater COC for AOC 617, based on its contribution to residential ILCR. Aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc were identified as COCs for AOC 617, based on their contributions to residential hazard projections.

Future Site Workers

Arsenic was identified as the only groundwater COC for AOC 617, based on its contribution to industrial ILCR. Arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc were identified as groundwater COCs for AOC 617, based on their contributions to future site worker hazard projections.

The extent of the COCs identified in groundwater is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, tap water RBCs were compared to each reported concentration for each COC identified above. Aluminum and arsenic were each detected at a concentration exceeding their respective tap water RBC in one first-quarter groundwater sample (617001), and do not appear to be associated with impacts at AOC 617. Cadmium, cobalt, nickel, thallium, and zinc exceeded their respective tap water RBCs in the second monitoring well location at AOC 617 (617002). Manganese exceeded its tap water RBC at each of these locations. The maximum concentration of manganese was detected in a well that contained excessive levels of possible plating solution components.

10.9.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone F. If this area were to be used as a residential site, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at AOC 617 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone F. This system is planned to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentrations were used as the exposure point concentrations for this site. Use of maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely for the maximum detected concentration to be representative of all soil constituents throughout the site. Groundwater risk/hazard was calculated using the maximum detected concentration of each COPC as an EPC. As with surface soil, it is unlikely that the concentration detected in first-quarter groundwater samples is representative of the site, and would generally overestimate risk and/or hazard. Although only two monitoring wells were installed, 617001 appears to be hydraulically downgradient of the most probable source areas of the site. As with any conceptual assessment, risk and/or hazard may be either underestimated or overestimated.

Frequency of Detection and Spatial Distribution

BEQs were detected above RBCs in only one of four surface soil samples; however, background levels of BEQs at NAVBASE have also exceeded RBCs. Additionally, many of the soil sample locations were situated underneath asphalt, which may help to explain the presence and source of this group of constituents.

Aluminum, arsenic, cadmium, cobalt, nickel, thallium, and zinc exceeded their respective tap water RBCs, each in one of two first-quarter groundwater samples. Manganese exceeded its tap water RBC in both first-quarter groundwater samples collected at AOC 617, but only exceeded its corresponding background value in one first-quarter groundwater sample. The generally high concentrations of metals detected in groundwater at AOC 617 appear to be site related, although the nature and extent of contamination in groundwater has not been positively identified.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty and variability inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for AOC 617. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, only arsenic and beryllium (2.6 mg/kg and 0.21 mg/kg, respectively) exceeded their RBCs (0.43 mg/kg and 0.15 mg/kg, respectively), but were below their Zone F background values (19.9 mg/kg and 1.05 mg/kg, respectively). No other soil constituent was reported at a concentration near its RBC (e.g., within 10% of its RBC).

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration which approached its RBC (e.g., within 10% of its RBC).

Groundwater is not currently used as a potable water source at AOC 617, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable source of potable water.

Background-related Risk

Soil

Arsenic and beryllium were detected in AOC 617 surface soil above their respective RBCs. These elements were not considered in the risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed RBCs. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of these elements.

The maximum surface soil concentration of arsenic (2.6 mg/kg) for AOC 617 equates with ILCRs of 7E-06 (based on the adult and child lifetime weighted average) and 1E-06 for the site worker. Therefore, background risk from arsenic at AOC 617 is greater than BEQ risk. Hazard quotients are 0.1 and 0.006 for the residential child and site worker, respectively. The maximum surface soil concentration of beryllium (0.21 mg/kg) equates with ILCRs of 2E-06 (based on the adult and child lifetime weighted average) and 2E-07 for the site worker. Hazard quotients are 0.0005 and 0.00003 for the residential child and site worker, respectively.

First-quarter Groundwater

All constituents that exceeded tap water RBCs in groundwater also exceeded corresponding background values in at least one sample. Therefore, no constituents were eliminated from consideration in the risk assessment based exclusively on background values for groundwater.

The maximum reported concentrations of the metals that were identified as primary contributors to HI projections at AOC 617, were all identified in the same well (617002). Subsequent sampling rounds identified the same analytes but at much lower concentrations. Cobalt was reported in the first groundwater sample collected from 617002 at a concentration of 298 μg/L. In the subsequent sampling round from the same monitoring well, the reported concentration of cobalt was reduced to 16.6 μg/L.

Initial groundwater samples from 617002 also identified manganese, nickel, and zinc at 4,850 μg/L, 604 μg/L, and 145,000 μg/L, respectively. Subsequent groundwater samples from the same monitoring well identified manganese, nickel, and zinc at 733 μg/L, 44.6 μg/L, and 11,000 μg/L, respectively. Thallium was detected at 21 μg/L in the groundwater sample initially collected from 617002, but was not detected in subsequent sampling rounds from the same well. Therefore, groundwater contamination may not be as significant as initial groundwater samples indicated. However, since the nature and extent of groundwater contamination has not been positively identified, inherent uncertainty is great.

10.9.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 617 were assessed for the future site worker and the future site resident under RME assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The groundwater pathway was based on ingestion of shallow groundwater represented by the initial quarter groundwater data. Table 10.9.21 presents the risk summary for each soil pathway/receptor group evaluated for AOC 617.

Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 617 are BEQs only. Figure 10.9.16 illustrates point risk estimates for AOC 617 surface soil pathways under a residential scenario. Table 10.9.22 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

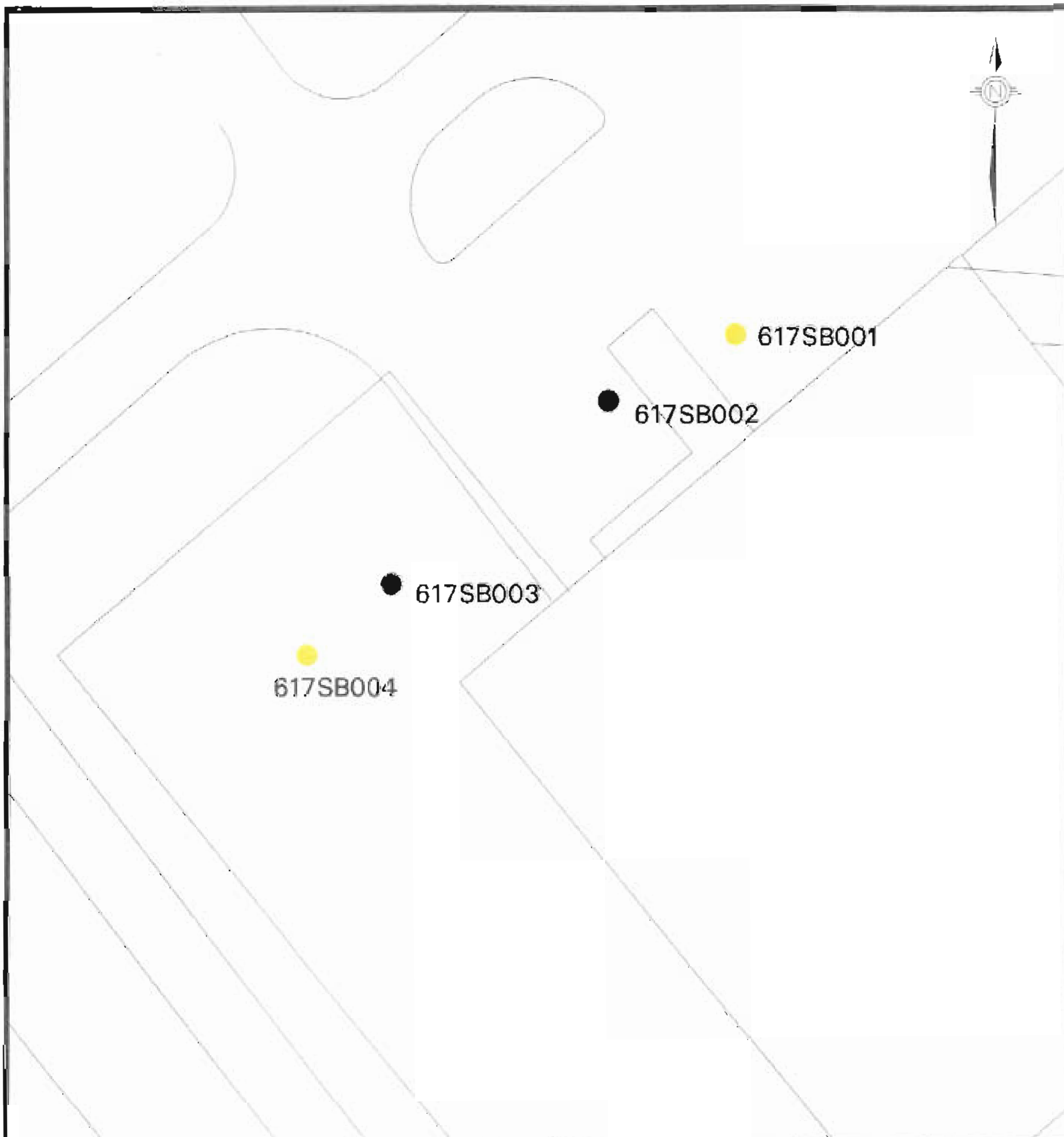
BEQs contributed to risk estimates at or above 1E-06 at 2 of 4 surface soil sample locations. Risks estimates ranged from 1E-06 (617SB001) to 3E-06 (617SB004). Noncarcinogenic COCs were not identified in surface soils at AOC 617; therefore HIs were not computed.

Soil — Site Worker Scenario

No industrial soil pathway COCs were identified for AOC 617.

Groundwater — Residential Scenario

Residential groundwater pathway COCs identified for AOC 617 include aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc. Figures 10.9-17 and 10.9-18 illustrate point risk and hazard estimates for AOC 617 groundwater pathways under a residential scenario. Table 10.9.23 summarizes the risk and hazard contribution of each COPC at each monitoring well location.



LEGEND

- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 80

ZONE F - RCRA FACILITY INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.9.16
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 617

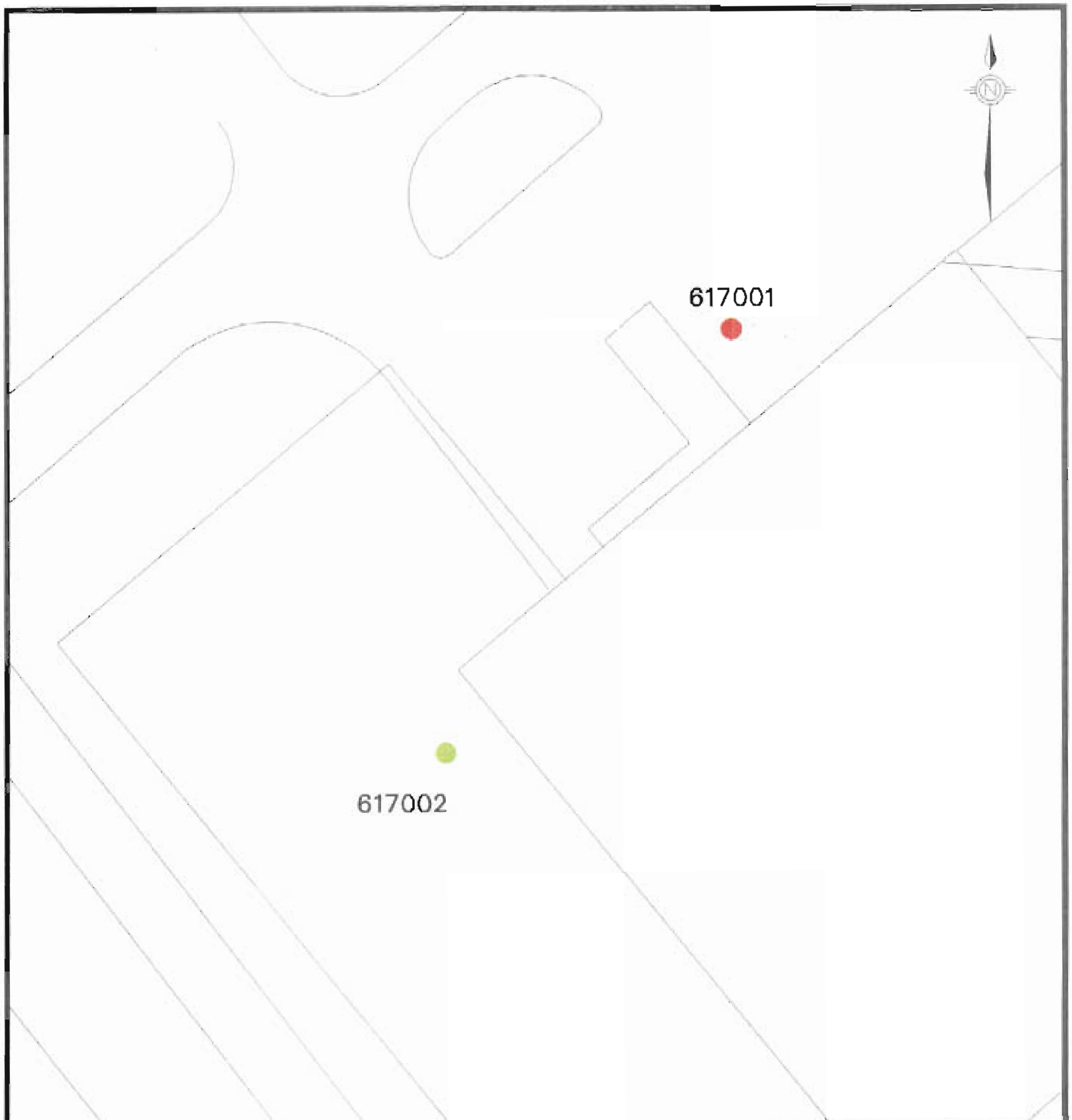
Table 10.9.21
Summary of Risk and Hazard
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	NA	NA	2E-06	NA	3E-07
	Dermal Contact	NA	NA	1E-06	NA	4E-07
Sum of Soil Pathways		NA	NA	3E-06	NA	7E-07
Groundwater	Ingestion	31	71	7E-04	11	2E-04
Sum of Groundwater Pathway		31	71	7E-04	11	2E-04
Sum of All Pathways		31	71	7E-04	11	2E-04

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

Table 10.9.22
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 617
NAVBASE Charleston, Zone F
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
617	B001	B(a)P Equiv.	67.82	UG/KG	NA	NA	1.12	100.00
		Total			NA		1.12	
617	B002	B(a)P Equiv.	ND	UG/KG	NA	NA	NA	NA
		Total			NA		NA	
617	B003	B(a)P Equiv.	ND	UG/KG	NA	NA	NA	NA
		Total			NA		NA	
617	B004	B(a)P Equiv.	204.25	UG/KG	NA	NA	3.38	100.00
		Total			NA		3.38	



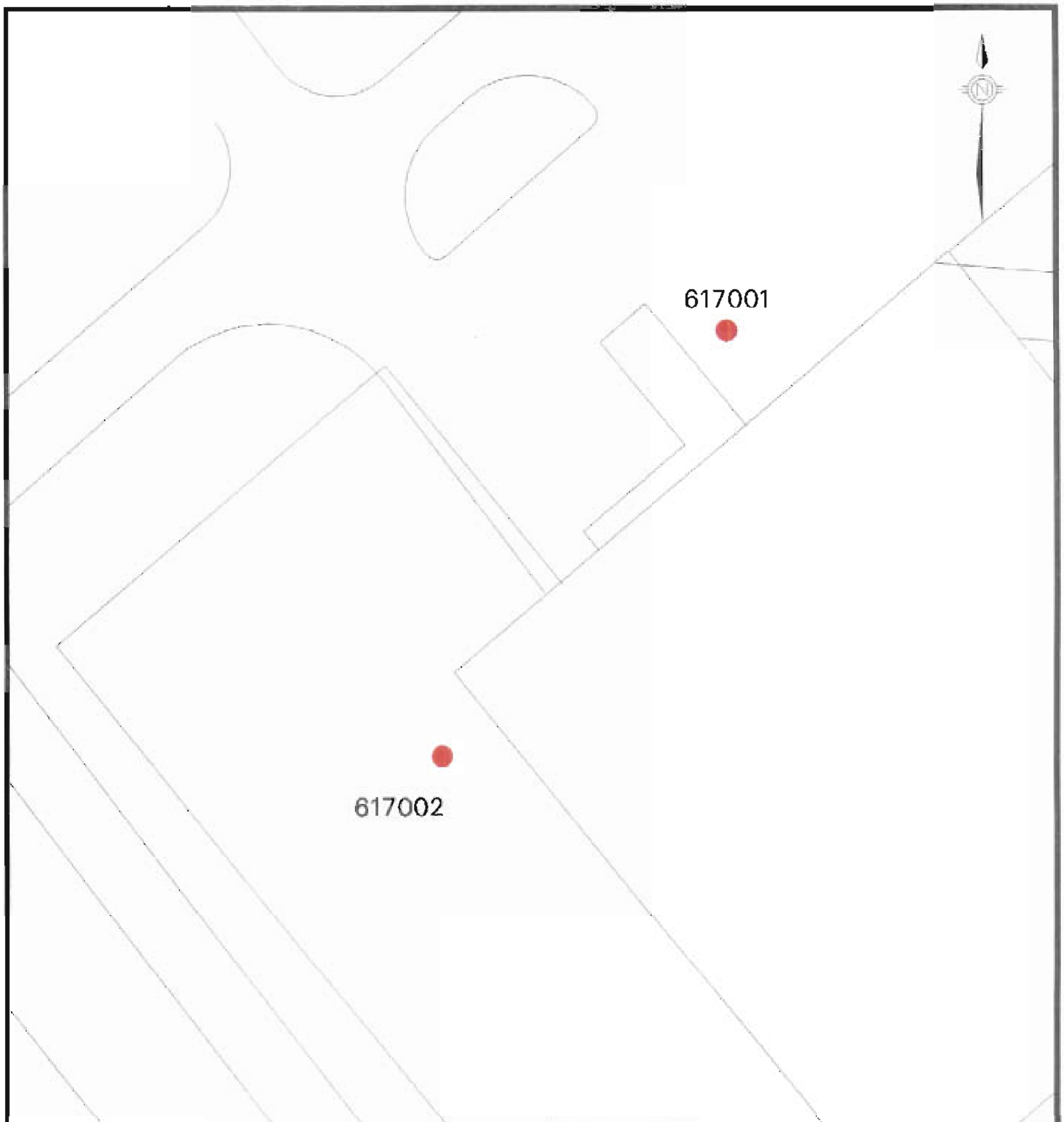
LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 90

ZONE F - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.9.17
POINT RISK ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 617



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 80

ZONE F - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.9.18
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 617

Table 10.9.23
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 617
NAVBASE Charleston, Zone F
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
617	G001	Aluminum (Al)	7420	UG/L	0.47	5.90	NA	NA
617	G001	Arsenic (As)	31.7	UG/L	6.75	84.08	707.20	100.00
617	G001	Cadmium (Cd)	ND	UG/L	NA	NA	NA	NA
617	G001	Cobalt (Co)	1.6	UG/L	0.00	0.02	NA	NA
617	G001	Manganese (Mn)	281	UG/L	0.78	9.72	NA	NA
617	G001	Nickel (Ni)	4.5	UG/L	0.01	0.18	NA	NA
617	G001	Thallium (Tl)	ND	UG/L	NA	NA	NA	NA
617	G001	Zinc (Zn)	37.6	UG/L	0.01	0.10	NA	NA
		Total			8.03		707.20	
617	G002	Aluminum (Al)	1450	UG/L	0.09	0.14	NA	NA
617	G002	Arsenic (As)	ND	UG/L	NA	NA	NA	NA
617	G002	Cadmium (Cd)	5.6	UG/L	0.72	1.11	NA	NA
617	G002	Cobalt (Co)	298	UG/L	0.32	0.49	NA	NA
617	G002	Manganese (Mn)	4850	UG/L	13.48	20.99	NA	NA
617	G002	Nickel (Ni)	604	UG/L	1.93	3.01	NA	NA
617	G002	Thallium (Tl)	21	UG/L	16.78	26.13	NA	NA
617	G002	Zinc (Zn)	145000	UG/L	30.90	48.12	NA	NA
		Total			64.22		NA	

Arsenic contributed to risk estimates above 1E-06 at one of two first-quarter groundwater sample locations (617001) with an estimated risk of 7E-04. All groundwater COCs at AOC 617 contributed to hazard projections exceeding unity at both first-quarter groundwater sample locations. HIs were 8 and 64 at 617001 and 617002, respectively. Arsenic, aluminum, and manganese were the primary contributors to hazard index projections at 617001, while cobalt, nickel, and zinc were secondary contributors. Arsenic accounted for nearly 85% of the hazard index at 617001. Cadmium, cobalt, manganese, nickel, thallium, and zinc were primary contributors to hazard index projections at 617002, while aluminum was a secondary contributor. Zinc contributed to approximately 48% of the hazard index at this location, thallium contributed approximately 26%, and manganese contributed approximately 21%.

10.9.6.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.9.24 for surface soil. Hazard-based RGOs were calculated based on the hypothetical child resident.

Groundwater

Shallow groundwater RGOs were based on the generic site resident scenario are shown in Table 10.9.25.

10.9.7 Corrective Measures Considerations

For AOC 617, the upper and lower soil intervals and shallow groundwater were investigated. A total of four soil samples were collected from the upper and lower intervals, with all of the samples collected beneath an asphalt pavement. Two monitoring wells were also sampled. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the upper soil interval and shallow groundwater.

Table 10.9.24
Remedial Goal Options for Surface Soil
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options **3** mg/kg	**1** mg/kg	**0.1** mg/kg	Risk-Based Remedial Goal Options **1E-06** mg/kg	**1E-05** mg/kg	**1E-04** mg/kg	Background Concentration mg/kg
Semivolatile Organic Compounds										
Benzo(a)pyrene equivalents	7.3	NA	0.2	ND	ND	ND	0.06	0.6	6	NA

NOTES:

EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential or site worker lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.9.25
Residential-Based Remedial Goal Options Shallow Groundwater
AOC 617
Naval Base Charleston, Zone F
Charleston, South Carolina

	Oral	Oral		Hazard-Based Remedial Goal Options			Risk-Based Remedial Goal Options				Background
	SF	RfD	EPC	**0.1**	**1.0**	**3**	**1E-06**	**1E-05**	**1E-04**	ARAR	Concentration
Chemical	(mg/kg-day)-	(mg/kg-day)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Aluminum (Al)	NA	1	7.42	1.6	16	47	NA	NA	NA	NA	0.224
Arsenic (As)	1.5	0.0003	0.032	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.05	0.0167
Cadmium (Cd)	NA	0.0005	0.0056	0.00078	0.0078	0.023	NA	NA	NA	0.005	0.00082
Cobalt (Co)	NA	0.06	0.298	0.094	0.94	2.8	NA	NA	NA	NA	0.0109
Manganese (Mn)	NA	0.023	4.85	0.036	0.36	1.1	NA	NA	NA	NA	2.01
Nickel (Ni)	NA	0.02	0.604	0.031	0.31	0.94	NA	NA	NA	0.1	0.00555
Thallium (Tl)	NA	8E-05	0.021	0.00013	0.0013	0.0038	NA	NA	NA	0.002	0.00558
Zinc (Zn)	NA	0.3	145	0.47	4.7	14	NA	NA	NA	NA	NA

NOTES:
EPC exposure point concentration
NA not applicable
ND not determined
- remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens

However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is paved with asphalt.

BEQs were the only compounds identified as COCs in the upper soil interval. The soil pathway cumulative residential exposure risk is 3E-06 and the cumulative HI was not calculated due to the lack of available risk information. Cumulative residential exposure risk is within USEPA's acceptable range of 1E-06 and 1E-04. The residential RGO for surface soil set for BEQs is 0.06 mg/kg, based on a target risk of 1E-06. Potential corrective measures, in addition to no further action for soil, and respective COCs are presented in Table 10.9.26.

Several COCs, including aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc, were identified in shallow groundwater for AOC 617. Aluminum and arsenic exceeded their respective tap water RBCs in only the first quarter groundwater sample from well 617001. Cadmium, cobalt, nickel, thallium, and zinc exceeded their respective tap water RBCs in well 617002. Manganese exceeded its tap water RBC at both locations. The groundwater pathway cumulative residential exposure risk is 7E-04 and the cumulative HI is 71. The cumulative residential exposure risk is within of USEPA's acceptable range of 1E-06 and 1E-04, however, the HI of 71 exceeds USEPA's acceptable HI of 1. The risk RGO for arsenic in shallow groundwater is 0.00044 mg/L. Hazard-based shallow groundwater RGOs for aluminum, cadmium, cobalt, manganese, nickel, thallium, and zinc are 16, 0.0078, 0.94, 0.36, 0.31, 0.0013, and 4.7 mg/L, respectively, based on a target HI of 1.

Potential corrective measures for the shallow groundwater and respective COCs are presented in Table 10.9.26. Corrective measures for AOC 617 are detailed in Section 9.

Table 10.9.26
Potential Corrective Measures for AOC 617

Medium	Compounds of Concern	Potential Corrective Measures
Soil	BEQs	a) No Action b) Intrinsic remediation and monitoring c) Containment by capping d) Excavation and landfill, if RCRA-nonhazardous waste e) In-situ, chemical and physical treatment f) Ex-situ, chemical and physical treatment
Shallow Groundwater	aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc	a) No Action b) Intrinsic remediation and monitoring c) Ex-situ, chemical and physical treatment

10.10 AOC 709, Former Fuel Distribution System Area 16

This site was included in the investigation of the base-wide Fuel Distribution System (FDS) at Charleston Naval Complex (CNC) as Area 16. During this study, elevated concentrations of inorganic analytes were detected in shallow groundwater above their respective screening criteria. Of primary concern were the concentrations of arsenic detected in well FDS16B. The CNC project team determined RCRA would be the most appropriate program to evaluate this site due to these elevated inorganics.

The source of this problem is unknown. A review of historical maps and aerial photographs identified no obvious source of this contamination. No known past or current activities in the area were distinguished as potential sources. The FDS pipeline associated with this area was used to convey fuel and not waste oil.

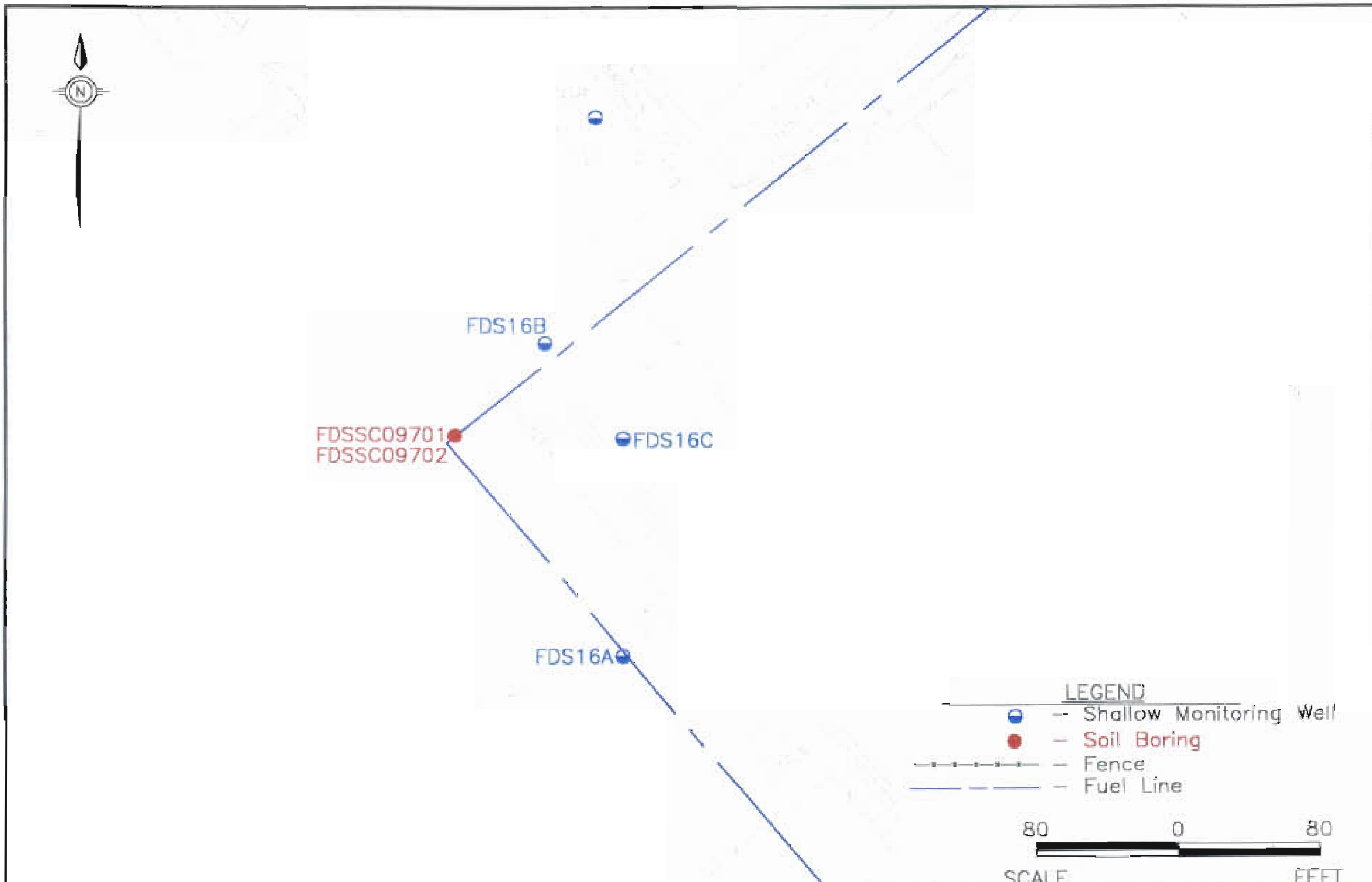
10.10.1 Site Geology and Hydrogeology

Figure 10.10-1 depicts the soil and groundwater sample locations associated with AOC 709. The surficial stratigraphy at AOC 709, based on the monitoring well boring at FDS16A, consists of organic silty clay overlying sand, clayey sand and clay. In accordance with the proposed investigation of the FDS, the stratigraphy of the other two well borings, (FDS16B, FDS16C) were logged using soil cuttings, no discrete samples were collected. The total depth of these wells were between 16 and 17 feet bgs. Boring logs are contained in Appendix A.

Figures 10.10-2 and 10.10-3 depict the shallow groundwater potentiometric surface and inferred flow direction in the shallow surficial aquifer at low and high-tides respectively. Shallow groundwater flow was consistent in direction and gradient during both tidal events. No slug testing was performed at this site.

10.10.2 Field Investigation Approach

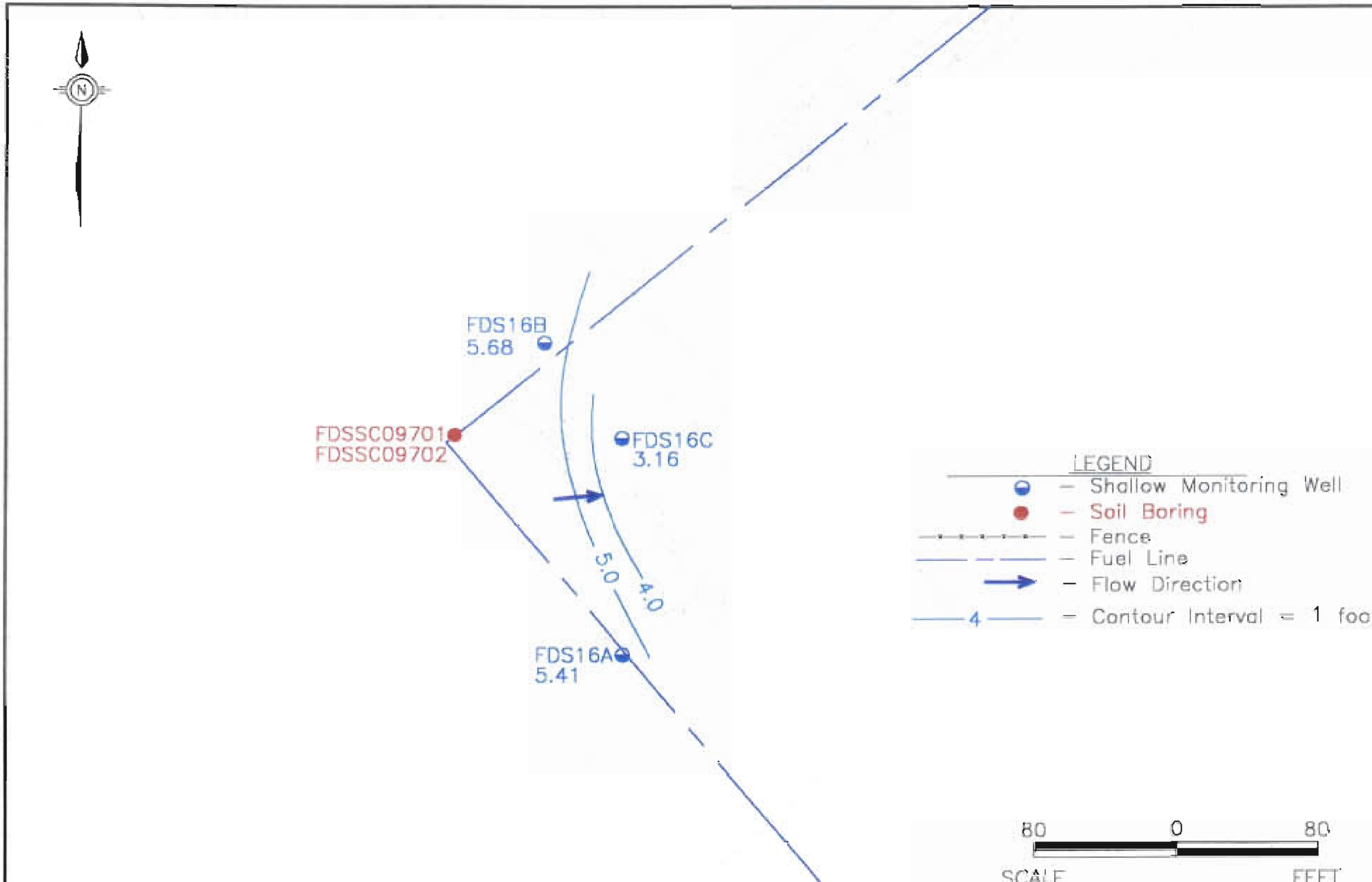
The objective of the field investigation at AOC 709 (former FDS Area 16) was to: (1) confirm the



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10-1
SOIL AND GROUNDWATER
SAMPLING LOCATIONS
AOC 709

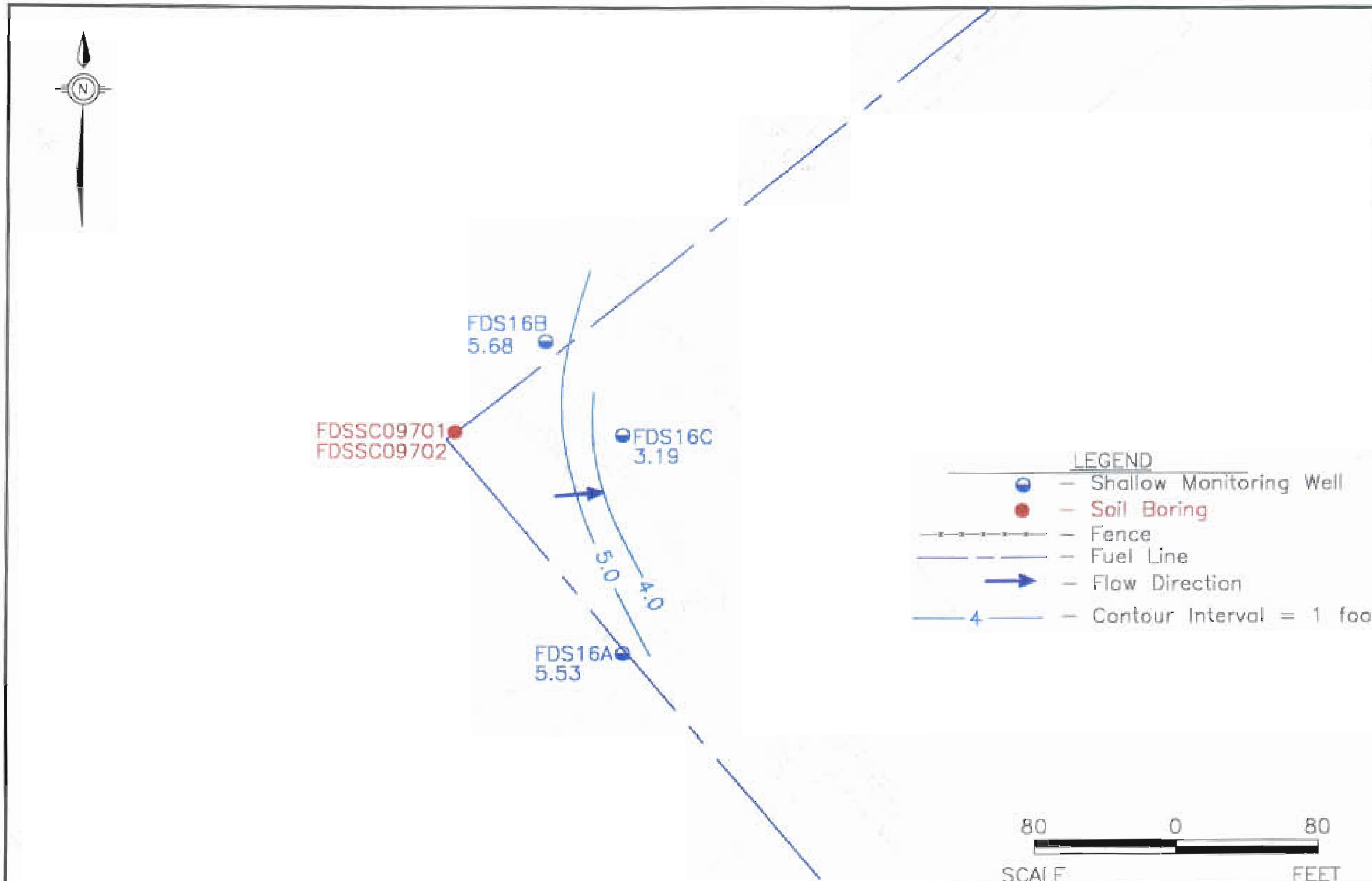
DWG DATE: 03/25/99 | DWG NAME: 2906B008



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC 709

DWG DATE: 03/25/99 | DWG NAME: 29068009



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10-3
SHALLOW GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC 709

DWG DATE: 03/25/99 | DWG NAME: 2906B010

presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required.

Media sampled within the investigation area included soil and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hollow stem auger drilling procedures used for shallow well installation; the Cone Penetrometer Testing (CPT) procedures used for subsurface soil sampling; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the data report for samples collected in Zone F.

10.10.3 Soil Sampling and Analysis

The approved final RFI work plan proposed screening of the fuel distribution pipeline system to detect probable areas which may require additional study to achieve the investigation objectives. CPT sample location FDSSC097 was placed near the fuel oil supply pipeline as shown on Figure 10.10-1. During the first phase of the screening, soil samples were collected from 7-9 and 9-11 feet bgs and analyzed for total petroleum hydrocarbons (TPH). These samples also exhibited an odor of fuel oil. To identify the constituents responsible for the elevated TPH, a subsequent sample was collected at the same location from 8-10 feet bgs and analyzed for VOCs, SVOCs, pesticides/PCBs and metals at DQO III. A duplicate sample was also collected and analyzed for Appendix IX parameters at DQO IV. The sample depth interval was selected to correspond to the burial depth of the pipeline. Table 10.10.1 summarizes the AOC 709 soil samples and analyses.

10.10.3.1 Nature of Contamination in Subsurface Soil

Organic compound analytical results for subsurface soil are summarized in Table 10.10.2. Inorganic analytical results for subsurface soil are summarized in Table 10.10.3. Table 10.10.4

Table 10.10.1
Zone F
AOC 709
Soil Samples and Analysis

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analysis	Remarks
FDSSC097	FDSSC09701	7 - 9	10/03/96	TPH-DRO and TPH-GRO	
	FDSSC09702	9 - 11	10/03/96		
	FDSSC09701	8 - 10	12/05/96	Note 1	
	FDSCC09701*			Note 2	

Notes:
1 = SW-846 (metals, cyanide, pesticide/PCBs, SVOCs, VOCs) at DQO Level III.
2 = Appendix IX Suite: Appendix IX (pesticide/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP-pesticides); cyanide, hex-chrome at DQO Level IV.
* = Duplicate Sample.

Table 10.10.2
Zone F
AOC 709
Organic Compound Analytical Results for Subsurface Soil

Parameters	Frequency of Detections	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (µg/kg)					
Carbon disulfide	1/1	6.0	6.0	32,000[a]	0
Ethylbenzene	1/1	7.0	7.0	13,000	0
Xylene (Total)	1/1	33.5	33.5	140,000	0
Semivolatile Organic Compounds (µg/kg)					
BEQs[1]	1/1	172	172	NA	0
Benzo(a)anthracene	1/1	120	120	2,000	0
Benzo(a)pyrene	1/1	135	135	8,000	0
Benzo(b)fluoranthene	1/1	130	130	5,000[b]	0
Benzo(k)fluoranthene	1/1	84	84	49,000[b]	0
Chrysene	1/1	180	180	160,000[b]	0
Indeno(1,2,3-cd)pyrene	1/1	110	110	14,000[a]	0
Acenaphthene	1/1	143	143	570,000[a]	0
Anthracene	1/1	160	160	12,000,000[a]	0
Benzo(g,h,i) perylene	1/1	140	140	1.14E+08	0
Benzoic Acid	1/1	140	140	400,000[a,c]	0

Table 10.10.2
Zone F
AOC 709
Organic Compound Analytical Results for Subsurface Soil

Parameters	Frequency of Detections	Range of Detections (μg/kg)	Mean of Detections (μg/kg)	Reference Conc.* (μg/kg)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (μg/kg) Cont.					
bis(2-Ethylhexyl)phthalate (BEHP)	1/1	67	67	3,600,000	0
Dibenzofuran	1/1	101	101	14,000	0
Diethylphthalate	1/1	99	99	470,000[a]	0
Fluoranthene	1/1	109	109	4,300,000[a]	0
Fluorene	1/1	210	210	560,000[a]	0
2-Methylnaphthalene	1/1	475	475	36,000	0
Naphthalene	1/1	120	120	61,000	0
Phenanthrene	1/1	655	655	1,300,000	0
Pyrene	1/1	260	260	4,200,000[a]	0
Dioxins(ng/kg)					0
Dioxin(2,3,7,8 - TCDD TEQs)[1]	1/1	0.1361	0.1361	1600	0

Notes:
[1] = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995)
a = Calculated values correspond to a noncancer hazard quotient of 1
b = Calculated values correspond to a cancer risk level of 1 in 1,000,000
c = SSL for pH of 6.8
* = Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
NA = Not applicable
BEQ = Benzo(a)pyrene Equivalents
μg/kg = Micrograms per kilogram
ng/kg = Nanograms per kilogram

Table 10.10.3
Zone F
AOC 709
Inorganic Compound Analytical Results for Subsurface Soil

Parameters	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Subsurface Soil Background Conc. (mg/kg)	Number of Samples Exceeding Reference
Inorganics (mg/kg)						
Aluminum (Al)	1/1	14,200	14,200	1,000,000	17,100	0
Arsenic (As)	1/1	14.4	14.4	29[b]	18.2	0
Barium (Ba)	1/1	24.1	24.1	1,600[b]	51.8	0
Beryllium (Be)	1/1	0.75	0.75	63[b]	1.2	0
Calcium (Ca)	1/1	1,830	1,830	NL	NL	NA
Chromium (Cr)	1/1	31.6	31.6	38[b]	32.2	0
Cobalt (Co)	1/1	2.9	2.9	2,000	6.85	0
Copper (Cu)	1/1	10.6	10.6	11,000	30.4	0
Iron (Fe)	1/1	18,950	18,950	NL	NL	NA
Lead (Pb)	1/1	18.7	18.7	400[c]	51.7	0
Magnesium (Mg)	1/1	3,445	3,445	NL	NL	NA
Manganese (Mn)	1/1	91.6	91.6	950	469	0
Mercury (Hg)	1/1	0.13	0.13	2.0[b]	0.23	0
Nickel (Ni)	1/1	6.2	6.2	130[b]	8.85	0

Table 10.10.3
Zone F
AOC 709
Inorganic Compound Analytical Results for Subsurface Soil

Parameters	Frequency of Detections	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Subsurface Soil Background Conc. (mg/kg)	Number of Samples Exceeding Reference
Potassium (K)	1/1	2,500	2,500	NL	NL	NA
Selenium (Se)	1/1	0.59	0.59	5	1.24	0
Sodium (Na)	1/1	5,380	5,380	NL	NL	NA
Vanadium (V)	1/1	46.0	46.0	6,000[a]	49.4	0
Zinc (Zn)	1/1	33.0	33.0	12,000[a,b]	84.2	0

Notes:

[a] = Calculated values correspond to a noncancer hazard quotient of 1
[b] = SSL for pH of 6.8
[c] = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA 1994a).
* = Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
mg/kg = Milligrams per kilogram
NL = Not listed
NA = Not applicable

Table 10.10.4
Zone F
AOC 709
Analytes Detected in Subsurface Soil

Parameters	Location	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (µg/kg)				
Carbon disulfide	FDSSC097	6.0	32,000[a]	NA
Ethylbenzene	FDSSC097	7.0	13,000	NA
Xylene (Total)	FDSSC097	33.5	140,000	NA
Semivolatile Organic Compounds (µg/kg)				
BEQs[1]	FDSSC097	172	NA	NA
Benzo(a)anthracene	FDSSC097	120	2,000	NA
Benzo(a)pyrene	FDSSC097	135	8,000	NA
Benzo(b)fluoranthene	FDSSC097	130	5,000[b]	NA
Benzo(k)fluoranthene	FDSSC097	84	49,000[b]	NA
Chrysene	FDSSC097	180	160,000[b]	NA
Indeno(1,2,3-cd)pyrene	FDSSC097	110	14,000[a]	NA
Acenaphthene	FDSSC097	143	570,000[a]	NA
Anthracene	FDSSC097	160	12,000,000[a]	NA
Benzo(g,h,i) perylene	FDSSC097	140	1.14E+08	NA

Table 10.10.4
Zone F
AOC 709
Analytes Detected in Subsurface Soil

Parameters	Location	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Semivolatile Organic Compounds (μg/kg) Cont.				
Benzoic Acid	FDSSC097	140	400,000[a,c]	NA
bis(2-Ethylhexyl)phthalate (BEHP)	FDSSC097	67	3,600,000	NA
Dibenzofuran	FDSSC097	101	14,000	NA
Diethylphthalate	FDSSC097	99	470,000[a]	NA
Fluoranthene	FDSSC097	109	4,300,000[a]	NA
Fluorene	FDSSC097	210	560,000[a]	NA
2-Methylnaphthalene	FDSSC097	475	36,000	NA
Naphthalene	FDSSC097	120	61,000	NA
Phenanthrene	FDSSC097	655	1,300,000	NA
Pyrene	FDSSC097	260	4,200,000[a]	NA
Dioxins(ng/kg)				
Dioxin(2,3,7,8 - TCDD TEQs)[1]	FDSSC097	0.1361	1,600	NA

Table 10.10.4
Zone F
AOC 709
Analytes Detected in Subsurface Soil

Parameters	Location	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)				
Aluminum (Al)	FDSSC097	14,200	1,000,000	17,100
Arsenic (As)	FDSSC097	14.4	29[c]	18.2
Barium (Ba)	FDSSC097	24.1	1600[c]	51.8
Beryllium (Be)	FDSSC097	0.75	63[c]	1.2
Calcium (Ca)	FDSSC097	1,830	NL	NL
Chromium (Cr)	FDSSC097	31.6	38[c]	32.2
Cobalt (Co)	FDSSC097	2.9	2,000	6.85
Copper (Cu)	FDSSC097	10.6	11,000	30.4
Iron (Fe)	FDSSC097	18,950	NL	NL
Lead (Pb)	FDSSC097	18.7	400[d]	51.7
Magnesium (Mg)	FDSSC097	3,445	NL	NL
Manganese (Mn)	FDSSC097	91.6	950	469
Mercury (Hg)	FDSSC097	0.13	2.0[c]	0.23
Nickel (Ni)	FDSSC097	6.2	130[c]	8.85

Table 10.10.4
Zone F
AOC 709
Analytes Detected in Subsurface Soil

Parameters	Location	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Potassium (K)	FDSSC097	2,500	NL	NL
Selenium (Se)	FDSSC097	0.59	5	1.24
Sodium (Na)	FDSSC097	5,380	NL	NL
Vanadium (V)	FDSSC097	46.0	6,000[a]	49.4
Zinc (Zn)	FDSSC097	33.0	12,000[a,c]	84.2

Notes:
a = Calculated values correspond to a noncancer hazard quotient of 1
b = Calculated values correspond to a cancer risk level of 1 in 1,000,000
c = SSL for pH of 6.8
d = A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994a)
* = Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
ND = Not detected
NT = Not taken
NL = Not listed
NA = Not applicable
μg/kg = Micrograms per kilogram
mg/kg = Milligrams per kilogram
ng/kg = Nanograms per kilogram
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.
All background values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group.

summarizes all analytes detected in subsurface soil at the site. Appendix D contains a complete analytical data report for all Zone F samples collected.

Volatile Organic Compounds in Subsurface Soil

Three VOCs were detected in the subsurface soil samples. Carbon disulfide, ethylbenzene, and xylene were detected in subsurface soil at concentrations far below their respective SSLs.

Semivolatile Organic Compounds in Subsurface Soil

Nineteen SVOCs were detected in the subsurface soil samples at AOC 709. None of these compounds were detected above their respective SSLs.

Pesticides and PCBs in Subsurface Soil

No pesticides or PCBs were detected in subsurface soil samples at AOC 709.

Other Organic Compounds in Subsurface Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in the duplicate sample at a concentration far below its SSL.

Inorganic Elements in Subsurface Soil

Nineteen metals were detected in the subsurface soil samples collected at AOC 709. All detections were below the respective SSLs. No inorganic element concentrations exceeded its Zone F background concentration. No background was established for calcium, iron, magnesium, potassium and sodium because they are considered to be essential nutrients.

10.10.4 Groundwater Sampling and Analysis

The approved final work plan proposed shallow monitoring wells to be installed as needed in areas where soil has been impacted. Based on the analytical results of soil samples collected at

AOC 709, three shallow wells were installed and sampled. Figure 10.10-1 presents the locations of these wells. The purpose of these wells was to: (1) assess groundwater quality and (2) identify contaminants which may be migrating from the site.

Groundwater samples were initially analyzed for VOCs, SVOCs, metals and cyanide and pesticides/PCBs at DQO III. During the second sampling round, cyanide was not an analytical parameter. Because no pesticides or PCBs were detected in the two previous sampling events, this analysis was not performed during the third sampling round. During the forth sampling round, metals were the only analytes of interest. Table 10.10.5 summarizes the groundwater samples and analyses at AOC 709. Appendix D contains a complete analytical data report for all Zone F samples collected.

10.10.4.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater are summarized in Table 10.10.6. Inorganic analytical results for groundwater are summarized in Table 10.10. 7. Table 10.10.8 presents a summary of all analytes detected at AOC 709.

Volatile Organic Compounds in Groundwater

No VOCs were detected in shallow groundwater during the three sampling events which analyzed for these compounds.

Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in shallow groundwater during the three sampling events which analyzed for these compounds.

Table 10.10.5
Zone F
AOC 709
Groundwater Sampling Summary

Sampling Round	Wells Sampled	Sampling Date	Sample Analysis	Comments
1	FDS16A	01/29/97	Standard Suite	
	FDS16B	01/29/97		
	FDS16C	01/29/97		
2	FDS16A	06/18/97	VOCs, SVOCs, metals, pesticides/PCBs	
	FDS16B	06/16/97		
	FDS16C	06/16/97		
3	FDS16A	04/22/98	VOCs, SVOCs, metals	
	FDS16B	04/20/98		
	FDS16C	04/20/98		
4	FDS16A	10/28/98	metals	
	FDS16B	10/28/98		
	FDS16C	10/28/98		

Notes:
Standard Suite = VOCs, SVOCs, metals, cyanide, pesticides/PCBs at DQO Level III.

Table 10.10.6
Zone F
AOC 709
Organic Compound Analytical Results for Groundwater

Parameters	Sample Round	Frequency of Detections	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL (μg/L)	Number of Samples Exceeding RBC
Pesticides (μg/L)							
Heptachlor	First	1/3	0.049	0.049	0.0023	0.4	1
	Second	0/3	ND	ND			0
	Third	0/0	NT	NT			-
	Fourth	0/0	NT	NT			-

Notes:

μg/kg = Micrograms per kilogram
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 1, 1998). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996) were used as reference concentrations.
MCL = Maximum contaminant level
SMCL = Secondary maximum contaminant level
ND = Not Detected/Not Determined
NT = Not Taken

Table 10.10.7
Zone F
AOC 709
Inorganic Analytical Results for Groundwater

Parameters	Sample Round	Frequency of Detections	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/ SMCL* (μg/L)	Shallow Background (μg/L)	Number of Samples Exceeding RBC
Inorganics (μg/L) (3 Shallow Samples)								
Alumium (Al)	First	3/3	574 - 3250	2045	3,700	50	224	0
	Second	2/3	710 - 754	732				0
	Third	3/3	91.2 - 1,200	484				0
	Fourth	2/3	46.1 - 65.3	55.7				0
Antimony (Sb)	First	3/3	3.1 - 4.2	3.7	1.5	6	ND	3
	Second	0/3	ND	ND				0
	Third	0/3	ND	ND				0
	Fourth	0/3	ND	ND				0
Arsenic (As)	First	3/3	9.4 - 28.5	15.9	0.045	50	16.7	3
	Second	3/3	6.2 - 94.6	37.6				3
	Third	3/3	9.8 - 254	97.8				3
	Fourth	3/3	6.7 - 236	95				3
Barium (Ba)	First	3/3	35.1 - 62	49.1	260	2,000	94.3	0
	Second	3/3	24.6 - 66.1	40.8				0
	Third	3/3	25 - 94.9	61.4				0
	Fourth	3/3	24.3 - 77.8	51.1				0
Cadmium (Cd)	First	0/3	ND	ND	1.8	5	0.82	0
	Second	0/3	ND	ND				0
	Third	2/3	0.35 - 0.55	0.45				0
	Fourth	1/3	0.44	0.44				0
Calcium (Ca)	First	3/3	129,000 - 252,000	188,333	NL	NL	NL	NA
	Second	3/3	117,000 - 263,000	199,667				NA
	Third	3/3	185,000 - 317,000	231,667				NA
	Fourth	3/3	134,000 - 264,000	212,000				NA
Chromium (Cr)	First	3/3	2.2 - 6.6	4.7	11	100	2.05	0
	Second	3/3	1.9 - 3.1	2.4				0
	Third	0/3	ND	ND				0
	Fourth	1/3	1.9	1.9				0
Cobalt (Co)	First	3/3	1.3 - 2.2	1.8	220	NL	10.9	0
	Second	2/3	1.2 - 2.0	1.6				0
	Third	0/3	ND	ND				0
	Fourth	2/3	1.2 - 1.3	1.25				0
Copper (Cu)	First	2/3	3.1 - 4.7	3.9	150	1,300/	ND	0
	Second	1/3	2.6	2.6		1,000		0
	Third	0/3	ND	ND				0
	Fourth	2/3	1.6 - 3.0	2.3				0

Table 10.10.7
Zone F
AOC 709
Inorganic Analytical Results for Groundwater

Parameters	Sample Round	Frequency of Detections	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/ SMCL* (μg/L)	Shallow Background (μg/L)	Number of Samples Exceeding RBC
Cyanide (CN)	First	3/3	4.6 - 4.9	4.8	73	200	3.3	0
	Second	0/0	NT	NT				0
	Third	0/0	NT	NT				0
	Fourth	0/0	NT	NT				0
Iron (Fe)	First	3/3	3,390 - 6,590	5,053	1,100	300	NL	3
	Second	3/3	3,690 - 23,300	11,990				3
	Third	3/3	13,000 - 53,200	33,400				3
	Fourth	3/3	5,130 - 22,400	12,443				3
Lead (Pb)	First	1/3	2.9	2.9	15	15	ND	0
	Second	1/3	1.7	1.7				0
	Third	0/3	ND	ND				0
	Fourth	0/3	ND	ND				0
Magnesium (Mg)	First	3/3	62,100 - 366,000	195,033	NL	NL	NL	NA
	Second	3/3	43,700 - 477,000	222,233				NA
	Third	3/3	50,400 - 378,000	180,133				NA
	Fourth	3/3	45,000 - 434,000	189,033				NA
Manganese (Mn)	First	3/3	787 - 867	817	73	50	2010	3
	Second	3/3	326 - 627	515				3
	Third	3/3	596 - 1,140	925				3
	Fourth	3/3	562 - 895	701				3
Mercury (Hg)	First	0/3	ND	ND	1.1	2	ND	0
	Second	0/3	ND	ND				0
	Third	0/3	ND	ND				0
	Fourth	3/3	0.2 - 0.29	0.24				0
Nickel (Ni)	First	3/3	4.7 - 5.3	4.97	73	100	5.55	0
	Second	1/3	1.5	1.5				0
	Third	1/3	1.5	1.5				0
	Fourth	2/3	2.1 - 4.0	3.05				0
Potassium (K)	First	3/3	19,000 - 106,000	62,967	NL	NL	NL	NA
	Second	3/3	14,400 - 156,000	84,333				NA
	Third	3/3	19,700 - 142,000	71,900				NA
	Fourth	3/3	14,500 - 154,000	69,400				NA
Silver (Ag)	First	0/3	ND	ND	18	100	ND	0
	Second	1/3	1.4	1.4				0
	Third	0/3	ND	ND				0
	Fourth	0/3	ND	ND				0
Sodium (Na)	First	3/3	86,400 - 2,500,000	1,312,133	NL	NL	NL	NA
	Second	3/3	47,500 - 4,290,000	1,975,833				NA
	Third	3/3	70,200 - 2,530,000	1,141,733				NA
	Fourth	3/3	70,900 - 5,820,000	2,221,967				NA

Table 10.10.7
Zone F
AOC 709
Inorganic Analytical Results for Groundwater

Parameters	Sample Round	Frequency of Detections	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/ SMCL* (μg/L)	Shallow Background (μg/L)	Number of Samples Exceeding RBC
Thallium (Tl)	First	2/3	4.6-6.4	5.5	0.26	2	2	2
	Second	0/3	ND	ND				0
	Third	0/3	ND	ND				0
	Fourth	0/3	ND	ND				0
Vanadium (V)	First	3/3	7.5-11.3	9.1	26	NL	1.58	0
	Second	3/3	5.8-8.6	6.8				0
	Third	0/3	ND	ND				0
	Fourth	2/3	2.9-4.1	3.5				0
Zinc (Zn)	First	1/3	45	45	1,100	5,000	ND	0
	Second	0/3	ND	ND				0
	Third	0/3	ND	ND				0
	Fourth	0/3	ND	ND				0

Notes:
ND = Not Detected/Not Determined
NL = Not Listed
NT = Not Taken
μg/L = Micrograms per liter
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table,* (USEPA, October 1,1998). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996) were used as reference concentrations.

Table 10.10.8
Zone F
AOC 709
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	4th Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Pesticides (μg/L)								
Heptachlor	FDS16A	**0.049**	ND	NT	NT	0.0023	0.4	NA
Inorganics (μg/L)								
Aluminum (Al)	FDS16A	3250	710	1200	46.1	3700	50	224
	FDS16B	2310	754	91.2	65.3			
	FDS16C	574	ND	160	ND			
Antimony (Sb)	FDS16A	**3.9**	ND	ND	ND	1.5	6	NL
	FDS16B	**4.2**	ND	ND	ND			
	FDS16C	**3.1**	ND	ND	ND			
Arsenic (As)	FDS16A	9.9	12.1	9.8	6.7	0.045	50	16.7
	FDS16B	**28.5**	**94.6**	**254**	**236**			
	FDS16C	9.4	6.2	**29.6**	**42.3**			
Barium (Ba)	FDS16A	35.1	24.6	25	24.3	260	2000	94.3
	FDS16B	50.2	31.7	94.9	51.3			
	FDS16C	62	66.1	64.4	77.8			
Cadmium (Cd)	FDS16B	ND	ND	0.35	0.44	1.8	5	0.82
	FDS16C	ND	ND	0.55	ND			

Table 10.10.8
Zone F
AOC 709
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	4th Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Calcium (Ca)	FDS16A	184,000	219,000	193,000	238,000	NL	NL	NL
	FDS16B	129,000	117,000	185,000	134,000			
	FDS16C	252,000	263,000	317,000	264,000			
Chromium (Cr)	FDS16A	6.6	1.9	ND	ND	11	100	2.05
	FDS16B	5.4	2.3	ND	ND			
	FDS16C	2.2	3.1	ND	1.9			
Cobalt (Co)	FDS16A	2.2	2.0	ND	1.3	220	NL	10.9
	FDS16B	1.3	ND	ND	1.2			
	FDS16C	1.8	1.2	ND	ND			
Copper (Cu)	FDS16A	3.1	2.6	ND	1.6	150	1300/1000	NL
	FDS16B	4.7	ND	ND	3.0			
Cyanide (CN)	FDS16A	4.9	NT	NT	NT	73	200	3.3
	FDS16B	4.9	NT	NT	NT			
	FDS16C	4.6	NT	NT	NT			
Iron (Fe)	FDS16A	**3,390**	**3,690**	**13,000**	**5,130**	1100	300	NL
	FDS16B	**5,180**	**23,300**	**53,200**	**22,400**			
	FDS16C	**6,590**	**8,980**	**34,000**	**9,800**			
Lead (Pb)	FDS16B	2.9	1.7	ND	ND	15	15	NL

Table 10.10.8
Zone F
AOC 709
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	4th Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Magnesium (Mg)	FDS16A	62,100	43,700	50,400	45,000	NL	NL	NL
	FDS16B	157,000	146,000	112,000	88,100			
	FDS16C	366,000	477,000	378,000	434,000			
Manganese (Mn)	FDS16A	798	326	596	562	73	50	2010
	FDS16B	867	627	1,140	895			
	FDS16C	787	593	1,040	646			
Mercury (Hg)	FDS16A	ND	ND	ND	0.24	1.1	2	NL
	FDS16B	ND	ND	ND	0.29			
	FDS16C	ND	ND	ND	0.20			
Nickel (Ni)	FDS16A	4.7	1.5	1.5	4.0	73	100	5.55
	FDS16B	5.3	ND	ND	2.1			
	FDS16C	4.9	ND	ND	ND			
Potassium (K)	FDS16A	19,000	14,400	19,700	14,500	NL	NL	NL
	FDS16B	63,900	82,600	54,000	39,700			
	FDS16C	106,000	156,000	142,000	154,000			
Silver (Ag)	FDS16C	ND	1.4	ND	ND	18	100	NL
Sodium (Na)	FDS16A	86,400	47,500	70,200	70,900	NL	NL	NL
	FDS16B	1,350,000	1,590,000	825,000	775,000			
	FDS16C	2,500,000	4,290,000	2,530,000	5,820,000			

Table 10.10.8
Zone F
AOC 709
Analytes Detected in Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	4th Quarter Conc.	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Shallow Background
Thallium (Tl)	FDS16B	**6.4**	ND	ND	ND	0.26	2	2
	FDS16C	**4.6**	ND	ND	ND			
Vanadium (V)	FDS16A	11.3	8.6	ND	ND	26	NL	1.58
	FDS16B	8.4	6.1	ND	2.9			
	FDS16C	7.5	5.8	ND	4.1			
Zinc (Zn)	FDS16B	45	ND	ND	ND	1,100	5,000	ND

Notes:
NL = Not Listed
ND = Not Detected/Not Determined
NA = Not Applicable
NT = Not Taken
* = Tap water RBCs (THQ=0.1) from *Risk-Based Concentration Table, January-June 1996* (USEPA, 1996b). MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e) were used as reference concentrations.
Bolded concentrations exceed both the RBC and the zone background.
All background water values for Zone F are based on twice the means of the grid sample concentrations. One grid sample from Zone E is included in each group. Background values for groundwater are based on two sampling rounds in two wells at each depth.

Pesticides and PCBs in Groundwater

Heptachlor was the only pesticide detected in shallow groundwater at AOC 709. It was detected in only the initial sampling event. The detected concentration 0.049 μg/L, exceeded the tap water RBC of 0.0023 μg/L but was below the MCL of 0.4 μg/L. Heptachlor was not detected in the next sampling event. No PCBs were detected in any of the events they were an analytical parameter.

Inorganic Elements in Groundwater

Twenty-one metals plus cyanide were detected in shallow groundwater samples at AOC 709. Arsenic and thallium were the only metals detected at concentrations which exceeded both the respective RBCs and Zone F background concentrations of the shallow surficial aquifer.

Antimony was detected at concentrations exceeding the RBC of 1.5 μg/L in all three samples collected during the initial sampling event. The MCL of 6 μg/L was not exceeded. No background concentration was determined for antimony in Zone F.

Arsenic was detected in all samples collected during the four sampling events. Concentrations of arsenic have generally increased over time. During the initial sampling event only one sample collected from FDS16B, exceeded the RBC and background. This detection was below the MCL of 50 μg/L. The second round exhibited an increase in arsenic in wells FDS16A and FDS16B. The detection in FDS16B exceeded the RBC, background and the MCL. The third sampling event exhibited a significant increase in arsenic at FDS16B and FDS16C. This distribution was similar in the fourth sampling round. A similar pattern of arsenic detections were observed in the adjacent Zone E shallow grid well GDE008. These arsenic concentrations ranged from 17.3 μg/L to a maximum of 160 μg/L. All detections exceeded both the tap water RBC and Zone F background concentration. The Zone E grid well samples were collected earlier than the AOC 709 samples. The fourth quarter Zone E sample date corresponds with the initial sampling of the AOC 709 wells. Appendix H of the draft Final Zone E RFI contains the analytical results for this well. Figure 10.10-4 illustrates the distribution of arsenic in shallow groundwater at AOC 709.

Iron exceeded its RBC in all samples collected, no background was determined for the essential nutrient iron.

Manganese was detected in all samples collected at AOC 709. All detections exceeded the RBC of 73 μg/L and the MCL of 50 μg/L. However, no detections exceeded the Zone F background of 2010 μg/L.

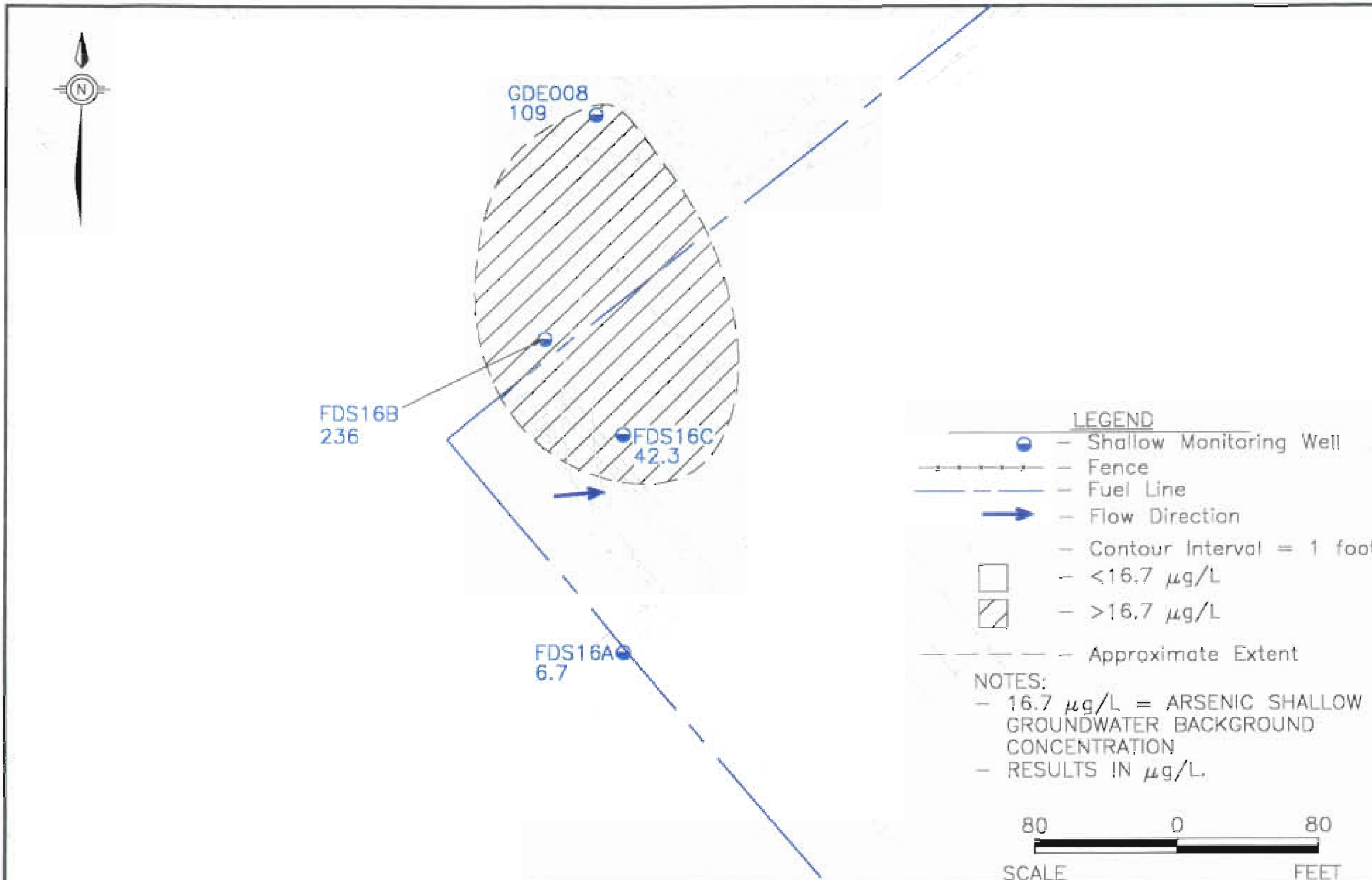
Thallium was detected in samples collected from FDS16B and FDS16C at concentrations exceeding the RBC, background and MCL during the initial sampling event. The subsequent events exhibited no thallium detections.

10.10.5 Fate and Transport Assessment for AOC 709

Environmental media sampled as part of the AOC 709 investigation include subsurface soil and shallow groundwater. Potential constituent migration pathways investigated include soil-to-groundwater and groundwater migration to human receptors and to surface water.

10.10.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.10.9 compares maximum detected constituent concentrations in subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels or (b) background concentrations. To provide a conservative screen, generic SSLs were used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).



ZONE F
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.10–4
ARSENIC IN SHALLOW GROUNDWATER
AOC 709

DWG DATE: 03/25/99 | DWG NAME: 2906B011

No constituents were detected in subsurface soil at concentrations exceeding their respective SSLs. Consequently, this pathway is considered invalid.

10.10.5.2 Groundwater Migration and Surface Water Cross-Media Transport

Table 10.10.9 also compares maximum detected organic constituent concentrations in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are screened against the greater of (a) risk-based drinking water concentrations or (b) corresponding background reference concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards. It should be noted that the risk-based pathway for shallow groundwater is currently an invalid pathway simply because there is no human consumption of the groundwater, e.g. there is no end-use receptor. This comparison is made for screening only and to develop strategies for long-term management of the groundwater should an area containing deleterious levels be identified.

One organic constituent - heptachlor - was present at concentrations that exceeded its RBC. It was detected in only one well in the initial sampling and has been non-detect since that time, invalidating the pathway for this parameter. The source for heptachlor is unknown, given its absence in site soil, but it is likely a residual from routine application on the adjacent grassy fields. Two inorganics - arsenic and thallium were present at concentrations that exceeded their RBCs. Arsenic shows an overall increase in concentration over four quarters of sampling, particularly in wells FDS16B and FDS16C. The source of arsenic may be related to the use of arsenate-based pesticides and/or herbicides and the adjacent open fields. Typically, the arsenate complexes are quite mobile, infiltration into groundwater is quite rapid and notable changes in

Table 10.10.9
Chemicals Detected in Subsurface Soil and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
Charleston Naval Complex, Zone F: AOC 709
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Carbon disulfide	NA	6	ND	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	NA	7	ND	NA	13000	1300	4.3	UG/KG	UG/L	NO	NO	NO
Xylene (total)	NA	33.5	ND	NA	140000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	NA	143	ND	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Anthracene	NA	160	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	NA	140	ND	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	NA	140	ND	NA	1.14E+08	730	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents	NA	172	ND	NA								
Benzo(a)anthracene	NA	120	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	NA	135	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	NA	130	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	NA	84	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	NA	180	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	NA	110	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	NA	101	ND	NA	14000	24	NA	UG/KG	UG/L	NO	NO	NO
Diethylphthalate	NA	99	ND	NA	470000	29000	75.9	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	NA	67	ND	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	NA	109	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	NA	210	ND	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	NA	475	ND	NA	36000	120	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	NA	120	ND	NA	61000	730	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	NA	655	ND	NA	1300000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	NA	260	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
Heptachlor	NA	ND	0.049	NA	23000	0.0023	0.0036	UG/KG	UG/L	NO	YES	YES
Dioxin Compounds												
Dioxin (TCDD TEQ)	NA	0.136	NA	NA	1600	0.45	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	NA	14200	3250	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	NA	ND	4.2	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	NA	14.4	254	NA	29	16.7	36	MG/KG	UG/L	NO	YES	YES
Barium	NA	24.1	94.9	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	NA	0.75	ND	NA	63	73	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	NA	ND	0.55	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	NA	31.6	6.6	NA	38	110	50	MG/KG	UG/L	NO	NO	NO
Cobalt	NA	2.9	2.2	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	NA	10.6	4.7	NA	11000	1500	2.9	MG/KG	UG/L	NO	NO	YES
Cyanide	NA	ND	4.9	NA	40	730	4.3	MG/KG	UG/L	NO	NO	YES
Lead	NA	18.7	2.9	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	NA	91.6	1140	NA	950	2010	NA	MG/KG	UG/L	NO	NO	NO
Mercury	NA	0.13	0.29	NA	2	11	0.025	MG/KG	UG/L	NO	NO	YES
Nickel	NA	6.2	5.3	NA	130	730	8.3	MG/KG	UG/L	NO	NO	NO
Selenium	NA	0.59	ND	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	NA	ND	1.4	NA	34	180	2.7	MG/KG	UG/L	NO	NO	NO
Thallium	NA	ND	6.4	NA	0.7	2.6	21.3	MG/KG	UG/L	NO	YES	NO
Vanadium	NA	46	11.3	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	NA	33	45	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

Notes:

* Screening Concentrations:

Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4 of RFI report
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 1998
Saltwater Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment, November 1995; Table 2
For inorganics, the tap water RBC value shown is the greater of the relevant screening value or the corresponding background reference value (thallium background reference value of 5.58 ug/L not used, pending results of basewide thallium study).

NA - Not available/Not applicable
ND - Not detected
DAF - Dilution and attenuation factor
RBC - Risk based concentration

MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram

groundwater concentrations over short time periods is common. Thallium was present in two wells during the first quarter, but has been non-detect since, effectively invalidating the pathway for this parameter.

One organic - heptachlor - and four inorganics - arsenic, copper, cyanide, and mercury - were detected in groundwater at concentrations that exceeded their respective surface water screening values. The trend and potential source for arsenic was previously discussed. Copper detections have been sporadic over four quarters of sampling, and concentrations have been only slightly greater than the screening value. The levels of both copper and cyanide suggest that the pathway with respect to them will not be significant, given the distance to nearest surface water, the Cooper River and the physical attenuation mechanisms of dispersion and dilution. Mercury was present in all three wells at similar concentrations during the fourth quarter, but was non-detect prior to that. The source for mercury is unknown, and its sudden appearance in site groundwater is problematic in terms of defining and understanding trends. The nearest surface water is approximately 1,200 feet to the northeast, and the direction of groundwater flow on a local scale is to the east. Therefore, unless the flow path changes azimuth outboard of the site, it is unlikely that site groundwater will discharge to the nearest surface water discharge point. Additionally, with the exception of arsenic, it is unlikely that any of the parameters would discharge at hazardous levels given the physical attenuation mechanisms associated with groundwater flow.

10.10.5.3 Fate and Transport Summary

No constituents were present in subsurface soil at concentrations exceeding their SSLs, thus the soil-to-groundwater pathway is considered invalid.

Only one organic parameter – heptachlor - was detected in groundwater at a concentration exceeding its RBC. This parameter was detected in only the first quarter samples, and has been non-detect since, effectively invalidating the groundwater ingestion and migration to surface water pathways.

Two inorganics – arsenic and thallium – were present in groundwater at levels that exceeded their RBCs. Arsenic exhibits an overall increase in concentration over four quarters of sampling, particularly in wells FDS16B and FDS16C. The source for arsenic may be linked to the use of arsenate-based pesticides and/or herbicides, which can infiltrate into groundwater quickly and exhibit rapid concentration changes. The data suggest that most of the groundwater mass underlying the site should be considered in risk management with respect to this parameter. Thallium was present in two wells during the first quarter, and has been non-detect since, effectively invalidating the groundwater ingestion and migration to surface water pathways with respect to this parameter.

One organic and four inorganics were present in groundwater above their respective surface water screening values. The heptachlor and arsenic distributions were discussed above.

Copper detections have been sporadic over four quarters of sampling; cyanide was present in all wells during the first quarter of sampling. Both of these parameters are at concentrations only slightly above their screening values, and given the physical attenuation mechanisms of dispersion and dilution, are not expected to be significant with respect to this pathway. Mercury was present in all wells during the fourth quarter, but was previously non-detect. The source and reason for the sudden appearance of mercury is unknown, and additional sampling data is needed to fully evaluate it's occurrence.

The nearest surface water is approximately 1,200 feet to the northeast, while local groundwater flow is to the east. It is therefore unlikely that site groundwater will discharge at the nearest discharge point, and it is also unlikely that parameters would be at hazardous levels at the nearest discharge point. One exception is arsenic, which should be considered during the risk management evaluation of this site.

10.10.6 Human Health Risk Assessment

10.10.6.1 Site Background and Investigative Approach

The purpose of the investigation at AOC 709, (former FDS Area 17) was the assessment of soil and groundwater potentially affected by the FDS pipelines. This area of potential impact is on the south side of Hobson Avenue, across the road from and west of Building 1172. The Cooper River lies approximately 1,200 feet to the east.

10.10.6.2 COPC Identification

Groundwater

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.10.10, the focus of this HHRA is on the following COPCs in shallow groundwater: antimony, arsenic, heptachlor, and thallium. Manganese was detected at a maximum concentration exceeding its RBC, however, this constituent was eliminated from consideration in the risk assessment based on comparison to its background concentration. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

10.10.6.3 Exposure Assessment

Exposure Setting

AOC 709 is located in an industrialized setting, approximately 1,200 feet southwest of the water front along the Cooper River. The site is mostly surrounded by buildings, roads, railroad right-of-ways, and paved parking areas to the north and east and grass-covered open fields to the west and south. In general, direct contact with soil, and migration of potential contaminants to groundwater or air is currently limited by these surface coverings. All potable water is provided through the

Table 10.10.10
Chemicals Present in Site Samples
AOC 709 - Shallow Groundwater
Charleston Naval Complex, Zone F
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration		Units	Number Exceeding	
									RBC	Reference		RBC	Ref.
Inorganics													
Aluminum (Al)		10	12	46.1	3250	916	17	52.6	3700	224	UG/L		6
Antimony (Sb)	*	3	12	3.1	4.2	3.73	1.6	5	1.5	NA	UG/L	3	
Arsenic (As)	*	12	12	6	254	61.6	NA	NA	0.045	16.7	UG/L	12	6
Barium (Ba)		12	12	24	94.9	50.6	NA	NA	260	94.3	UG/L		1
Cadmium (Cd)		3	12	0.35	0.55	0.45	0.3	0.5	1.8	0.82	UG/L		
Calcium (Ca)	N	12	12	117000	317000	207917	NA	NA	NA	NA	UG/L		
Chromium (Cr)		7	12	1.9	6.6	3.34	0.7	3.4	11	2.05	UG/L		5
Cobalt (Co)		7	12	1.2	2.2	1.57	0.8	1	220	10.9	UG/L		
Copper (Cu)		5	12	1.6	4.7	3.00	0.8	2.3	150	NL	UG/L		
Cyanide (CN)		3	3	4.6	4.9	4.80	NA	NA	73	3.3	UG/L		3
Iron (Fe)	N	12	12	3390	53200	15722	NA	NA	NA	NA	UG/L		
Lead (Pb)		2	12	1.7	2.9	2.3	0.9	1.7	15	NA	UG/L		
Magnesium (Mg)	N	12	12	43700	477000	196608	NA	NA	NA	NA	UG/L		
Manganese (Mn)		12	12	326	1140	740	NA	NA	73	2010	UG/L	12	
Mercury (Hg)		3	12	0.2	0.29	0.24	0.1	0.29	1.1	NA	UG/L		
Nickel (Ni)		7	12	1.5	5.3	3.43	0.7	1.1	73	5.55	UG/L		
Potassium (K)	N	12	12	14400	156000	72150	NA	NA	NA	NA	UG/L		
Silver (Ag)		1	12	1.4	1.4	1.4	1	1.4	18	NA	UG/L		
Sodium (Na)	N	12	12	47500	5820000	1662917	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	2	12	4.6	6.4	5.50	2.7	5.7	0.26	2	UG/L	2	2
Vanadium (V)		8	12	2.9	11.3	6.84	0.8	3.7	26	1.58	UG/L		8
Zinc (Zn)		1	12	45	45	45.00	0.4	31.8	1100	NA	UG/L		
Pesticides													
Heptachlor	*	1	6	0.049	0.049	0.049	0.04	0.04	0.0023	NA	UG/L	1	

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - microgram per liter
NA - Not applicable

city's water supply. Groundwater is not currently nor anticipated to be used in the future as potable or process water. Groundwater exposure pathways would not be completed if the municipal water supply is kept in place. As a highly conservative estimate of potential risk/hazard due to groundwater pathways, a residential scenario and an industrial scenario were considered for AOC 709.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents.

The hypothetical future site worker scenario assumes continuous exposure. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The resident child scenario was considered to be conservatively representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater. Uniform exposure was assumed for all sample locations. No VOCs were reported in AOC 709 groundwater samples at concentrations exceeding residential RBCs; therefore, the inhalation of volatiles pathway was not addressed for this site. Table 10.10.11 presents the justification for exposure pathways assessed in this HHRA.

Table 10.10.11
Exposure Pathways Summary — AOC 709
Charleston Naval Complex — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at AOC 709.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or nonresidential water at AOC 709.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at AOC 709. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	No	Surface soil samples were not taken at this site.

Table 10.10.11
Exposure Pathways Summary — AOC 709
Charleston Naval Complex — Zone F
Charleston, South Carolina

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Soil, Dermal contact	No	Surface soil samples were not taken at this site.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

As discussed in Section 7 of this RFI, UCLs are generally calculated for datasets consisting of at least 10 samples. Table 10.10.12 summarizes the determination of the groundwater EPCs. Most sampling regimes are designed to define the extent of a plume, potentially resulting in the biased placement of monitoring wells in uncontaminated areas of the aquifer, thus causing a low bias on concentration. As a result, current EPA guidance favors the use of the arithmetic mean in the most concentrated area of the plume as the EPC for groundwater COPCs. Since AOC 709 groundwater COPCs were not members of a well-defined plume, a simplifying assumption was made. It defined a separate plume defined by the monitoring well reporting the maximum concentration for each COPC. To guard against any inadequacies in this simplification, the traditional 95% UCL was calculated based on the data from all monitoring wells at a given site. Whichever was larger — the arithmetic mean of detected concentrations or the 95% UCL — was selected as the EPC for a given parameter at a given site. If the 95% UCL was exceeded by the maximum reported concentration, then the maximum concentration was selected as the EPC for that COPC. The 95% UCLs calculated for antimony and thallium exceeded their mean concentrations in the most concentrated area of their respective "plumes". As a result 95% UCLs

Table 10.10.12
Determination of Groundwater EPCs
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

	Natural Log Transformed						Average		
	n	mean	SD	H-stat	95% UCL (mg/L)	Maximum Conc. (mg/L)	Conc. in Plume (mg/L)	EPC (mg/L)	
Antimony (Sb)	12	-6.238	0.516	2.162	0.0031	0.0042	0.0024	0.0031	UCL
Arsenic (As)	12	-3.652	1.328	3.546	0.26	0.254	0.153	0.25	MAX
Heptachlor	6	-10.670	0.366	NA	NA	4.9E-05	3.5E-05	4.9E-05	MAX
Thallium (Tl)	12	-5.954	0.425	2.054	0.0037	0.0064	0.0034	0.0037	UCL

NOTES:

mean arithmetic mean of the logtransformed data
n number of samples analyzed
SD standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA not applicable
TEF toxic equivalency factor
EPC exposure point concentration
UCL 95 percentile upper confidence level mean
MAX maximum reported concentration

were selected as EPCs for antimony and thallium. The 95% UCL for arsenic (0.254 μg/L) was exceeded by its maximum reported concentration. As a result, the maximum reported concentration was selected as the EPC for arsenic. Since there were only 6 data points for heptachlor the maximum reported concentration was selected as its EPC.

Quantification of Exposure

Groundwater

The CDIs for groundwater ingestion, calculated as described in Section 7, are presented in Table 10.10.13.

10.10.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.10.14 presents toxicological information specific to each COPC identified at AOC 709. This information was used in the quantification of risk/hazard associated with groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. Due to frequent industrial use, the primary exposure route for antimony to the general population is food. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaassen, et al, 1986). The oral RfD is based on a lowest-observed-adverse-effects-level (LOAEL) of 0.35 mg/kg bw/day, an uncertainty factor of 1000, and a modifying factor of 1 (IRIS, 1995).

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular

Table 10.10.13
Chronic Daily Intakes
Ingestion of COPCs in Shallow Groundwater
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Antimony (Sb)	0.0031	8.56E-05	2.00E-04	4.71E-05	3.06E-05	1.09E-05
Arsenic (As)	0.25	6.96E-03	1.62E-02	3.83E-03	2.49E-03	8.88E-04
Heptachlor	4.9E-05	1.34E-06	3.13E-06	7.38E-07	4.79E-07	1.71E-07
Thallium (Tl)	0.0037	1.01E-04	2.36E-04	5.57E-05	3.62E-05	1.29E-05

NOTES:
lwa Lifetime weighted average
CDI Chronic Daily Intake
H-CDI Noncarcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.10.14

Toxicological Reference Information

for Chemicals of Potential Concern

AOC 709

Charleston Naval Complex, Zone F

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
Chemical	**Oral Reference Dose (mg/kg-day)**		**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**		**Inhalation Slope Factor (kg-day/mg)**		**Weight of Evidence**	**Tumor Type**
Antimony	0.0004	a	L	whole body/blood increased mortality	1,000	NA	NA	NA	NA	NA		NA		D	NA
Arsenic	0.0003	a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5	a	15.1	a	A	various
Heptachlor	0.0005	a	L	liver weight increase	300	NA	NA	NA	NA	4.5	a	4.55	a	B2	liver tumors
Thallium	7E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA	NA	NA	NA	NA		NA		D	NA

Notes:

a = Integrated Risk Information System (IRIS)

NA = Not applicable or not available

H = High confidence

L = Low confidence

M = Medium confidence

effects (Klaassen et al., 1986). As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. USEPA set 0.3 μg/kg/day as the oral RfD for arsenic based on a no-observed-adverse-effects-level (NOAEL) of 0.8 μg/kg-day in an epidemiological study. An uncertainty factor of 3 and a modifying factor of 1 were used for the derivation of the oral RfD. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingestion is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set an oral value of 1.5 $(mg/kg/day)^{-1}$ for arsenic. As listed in IRIS, the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic.

Heptachlor is a man-made chemical that was used in the past for killing insects in homes, buildings, and on food crops. Pure heptachlor is a white powder. Technical-grade heptachlor is a tan powder and has a lower level of purity than pure heptachlor. Heptachlor smells somewhat like camphor, and does not burn easily or explode (ATSDR, 1991).

No studies were located regarding lethal effects in humans after oral exposure to heptachlor. There are no data on chronic oral exposures in humans. There are occupational studies of workers engaged in the manufacture of heptachlor in which the exposures are presumed to be predominantly inhalation with contributions from the dermal route. No adverse health effects have been identified in these cohorts that could be positively associated with heptachlor exposure.

Heptachlor has been issued the USEPA weight-of-evidence classification of B2, probable human carcinogen (IRIS, 1993). Heptachlor has an oral RfD of 5E-04 mg/kg - day, an oral SF of 4.5 (mg/kg - day) $^{-1}$, and an inhalation SF of 4.55 (mg/kg - day) $^{-1}$ (IRIS, 1996).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 0.00007 mg/kg-day (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

10.10.6.5 Risk Characterization

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under both residential and site worker scenarios based on the results of four quarter sampling events. Exposure pathways were evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Table 10.10.15 presents the risk and hazard for the ingestion pathway. Since no VOCs were identified as COPCs in groundwater at AOC 709, the inhalation pathway was not addressed at this site.

Hypothetical Site Residents

Antimony, arsenic, heptachlor, and thallium were the only COPCs identified in shallow groundwater. Arsenic was the primary contributor and heptachlor was a secondary contributor to ILCR projections associated with AOC 709 for the groundwater ingestion pathway. The ILCR for the future residential scenario is 6E-03. The HIs for the adult and child resident are 25 and

Table 10.10.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Shallow Groundwater Ingestion
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Antimony (Sb)	0.0004	NA	0.21	0.50	ND	0.076	ND
Arsenic (As)	0.0003	1.5	23.2	54.1	5.7E-03	8.3	1.3E-03
Heptachlor	0.0005	4.5	0.0027	0.0063	3.3E-06	0.00096	7.7E-07
Thallium (Tl)	7E-05	NA	1.45	3.37	ND	0.52	ND
SUM Hazard Index/ILCR			25	58	6E-03	9	1E-03

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

58 respectively. Antimony, arsenic, and thallium were the contributors to HI projections for the ingestion pathway.

Hypothetical Site Workers

The groundwater pathway risk for the site worker scenario is 1E-03 and the hazard index for the ingestion pathway is 9. Arsenic was the primary contributor to ILCR projections and HI projections associated with the groundwater ingestion pathway. Thallium was also a contributor to HI projections.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 709 or other areas of Zone F. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater quality.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a HI threshold of 1 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative HI above 1, and whose individual ILCR exceeds 1E-06 or whose hazard quotient (HQ) exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.10.16 presents the COCs identified for AOC 709 shallow groundwater.

Table 10.10.16
Summary of Risk and Hazard-based COCs
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs
Groundwater	Ingestion							
Pathways		Antimony (Sb)	0.21	0.50	ND	0.076	ND	1
		Arsenic (As)	23.2	54.1	5.7E-03	8.3	1.3E-03	1 2 3 4
		Heptachlor	0.0027	0.0063	3.3E-06	0.00096	7.7E-07	2
		Thallium (Tl)	1.45	3.37	ND	0.52	ND	1 3
Groundwater Pathway Sum			25	58	6E-03	9	1E-03	
Sum of All Pathways			25	58	6E-03	9	1E-03	

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR

Groundwater

Future Site Residents

Arsenic and heptachlor were identified as groundwater pathway COCs based on their contribution to cumulative residential ILCR projections. Antimony, arsenic, and thallium were identified as groundwater pathway COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

Arsenic was identified as a groundwater pathway COC based on its contribution to cumulative industrial ILCR projections. Arsenic and thallium were identified as groundwater pathway COCs based on their contribution to cumulative residential HI projections.

10.10.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Current site workers are not exposed to site groundwater.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of this area of Zone F. If this area were to be used as a residential site, the buildings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Shallow groundwater is not currently used at AOC 709 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone F. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The 95% UCL, arithmetic mean of the detected concentrations, or only detected concentration was applied as the EPC for groundwater. Region IV guidance states that the average concentration of each COPC in the most concentrated area of the plume should be used as the EPC. Since a plume cannot be readily defined, this guidance applies only marginally. Groundwater data variability contributes greatly to uncertainty through spatial variability. Ninety-five percent UCLs were calculated to provide point estimates for groundwater to account for this uncertainty, thus providing an upper bound estimate for modeling exposure. For any given COPC, the placement of monitoring wells in uncontaminated areas of the aquifer could cause a low bias on the 95% UCL. As a result, the arithmetic mean of detected concentrations was compared to the 95% UCL and the greater of the two was selected as the EPC. When the 95% UCL exceeded the maximum reported concentration, the maximum concentration was selected as the EPC. To address these uncertainties and to provide additional perspective, risk/hazard maps were included in the Risk Summary Section.

Frequency of Detection and Spatial Distribution

Antimony was detected in the three first quarter groundwater samples at concentrations exceeding the tap water RBC. The concentrations decreased to nondetect in the second, third and fourth quarter sampling events. Arsenic was detected at a concentration exceeding its tap water RBC in all twelve groundwater samples. The four quarterly samples from monitoring well FDS16B and the third and fourth quarter samples from monitoring well FDS16C also exceeded the background value for arsenic. The only detection of heptachlor exceeded its tap water RBC in the first quarter groundwater sample from monitoring well FDS16A. Thallium was detected at a concentration exceeding its tap water RBC in two first quarter groundwater samples from monitoring wells FDS16B and FDS16C. The same two samples exceeded the MCL for thallium. The concentrations decreased to nondetect in the second, third and fourth quarter sampling events.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Groundwater

A conservative screening process was used to identify COPCs for AOC 709. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC). Manganese was reported at a maximum concentrations exceeding its RBC and was eliminated from consideration in the risk assessment based on comparison to its background concentration.

Groundwater is not currently used as a potable water source at AOC 709, nor is it used in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Background-related Risk

Manganese was detected in groundwater samples at a concentration exceeding its RBC. It was eliminated from consideration in the risk assessment based on a comparison to its corresponding background value. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of manganese.

The maximum groundwater concentration of manganese (1,140 μg/L) equates with HQs of 1.36 and 0.97 for the residential child and site worker scenarios, respectively. The background concentration of manganese (2,010 μg/L) equates with HQs of 2.4 and 1.7, respectively, for the resident child and site worker.

10.10.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 709 were assessed for the future site worker and the future site resident under reasonable maximum exposure assumptions. The groundwater pathway included ingestion and was based on four quarters of groundwater data. Table 10.10.17 presents the risk summary for each pathway/receptor group evaluated for AOC 709.

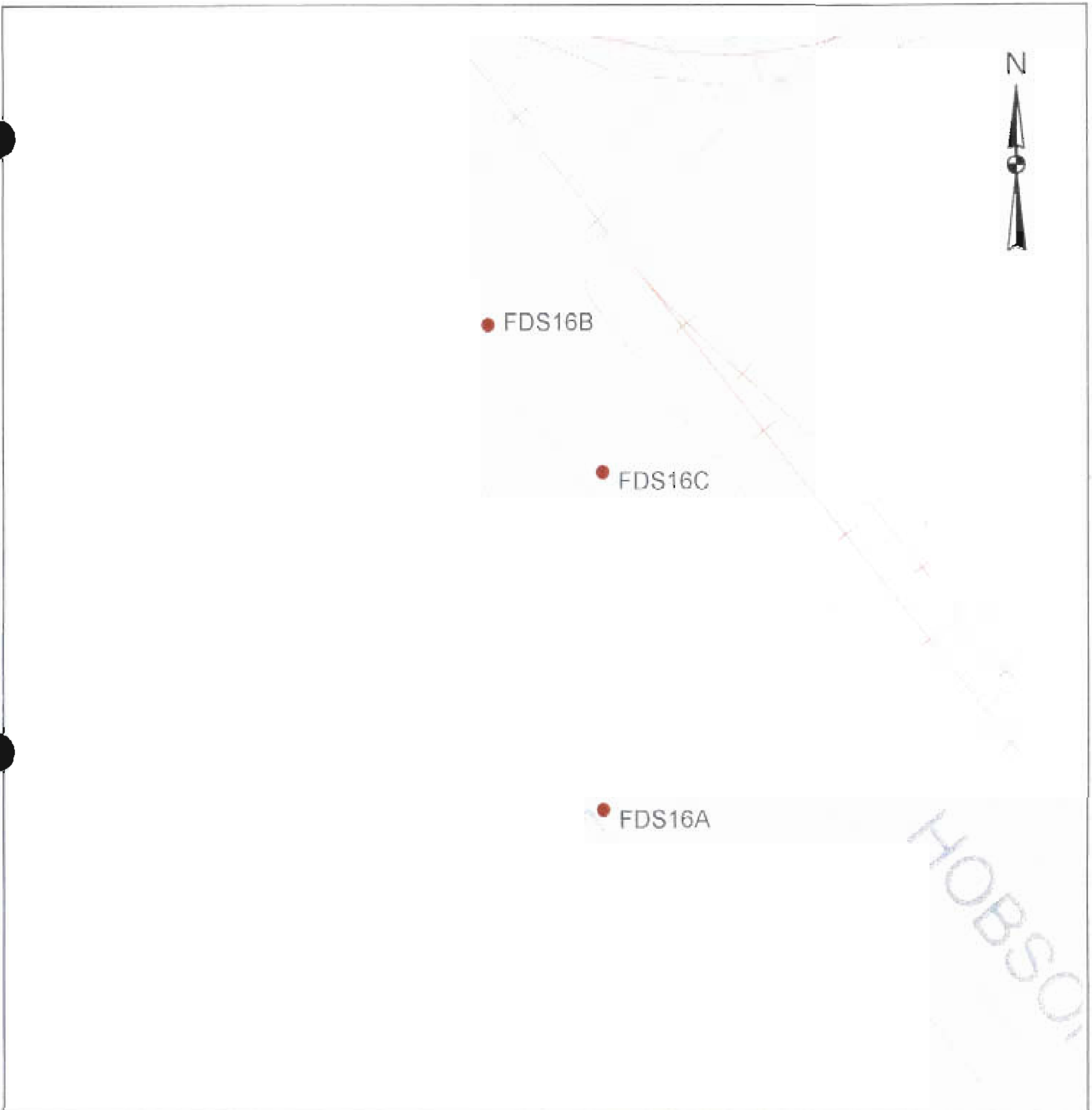
Groundwater – Residential Scenario

Antimony, arsenic, heptachlor, and thallium were identified as groundwater pathway COCs. As shown in Figure 10.10-5 and Table 10.10.18, arsenic and heptachlor were contributors to risk projections for AOC 709 groundwater. Risk estimates ranged from 1.4E-04 (FDS16C02) to 5.7E-03 (FDS16B03), with a mean ILCR of 1.4E-03. Arsenic and thallium were the primary

Table 10.10.17
Summary of Risk and Hazard
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Groundwater	Ingestion	25	58	6E-03	9	1E-03
Sum of All Pathways		25	58	6E-03	9	1E-03

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



LEGEND

- NO COPCs
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

40 0 40 80 Feet

ZONE F - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10-5
AOC 709

POINT RISK ESTIMATES FOR
GROUNDWATER
RESIDENTIAL SCENARIO

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Table 10.10.18
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Sample ID	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
FDS16A01	Antimony (Sb)	3.9	UG/L	0.623	NA
FDS16A01	Arsenic (As)	9.9	UG/L	2.110	220.86
FDS16A01	Heptachlor	0.049	UG/L	0.013	6.60
			Total	2.745	227.46
FDS16A02	Arsenic (As)	12.1	UG/L	2.578	269.94
			Total	2.578	269.94
FDS16A03	Arsenic (As)	9.8	UG/L	2.088	218.63
			Total	2.088	218.63
FDS16A04	Arsenic (As)	6.7	UG/L	1.428	149.47
			Total	1.428	149.47
FDS16B01	Antimony (Sb)	4.2	UG/L	0.671	NA
FDS16B01	Arsenic (As)	28.5	UG/L	6.073	635.81
FDS16B01	Thallium (Tl)	6.4	UG/L	5.114	NA
			Total	11.858	635.81
FDS16B02	Arsenic (As)	94.6	UG/L	20.158	2110.45
			Total	20.158	2110.45
FDS16B03	Arsenic (As)	254	UG/L	54.125	5666.54
			Total	54.125	5666.54
FDS16B04	Arsenic (As)	236	UG/L	50.289	5264.97
			Total	50.289	5264.97
FDS16C01	Antimony (Sb)	3.1	UG/L	0.495	NA
FDS16C01	Arsenic (As)	9.4	UG/L	2.003	209.71
FDS16C01	Thallium (Tl)	4.6	UG/L	3.676	NA
			Total	6.174	209.71
FDS16C02	Arsenic (As)	6.2	UG/L	1.321	138.32
			Total	1.321	138.32
FDS16C03	Arsenic (As)	29.6	UG/L	6.307	660.35
			Total	6.307	660.35
FDS16C04	Arsenic (As)	42.3	UG/L	9.014	943.68
			Total	9.014	943.68

contributors to hazard estimates, antimony was a secondary contributor. Figure 10.10-6 illustrates point hazard estimates for groundwater for the residential scenario. Hazard estimates ranged from 1.3 (FDS16C02) to 54 (FDS16B03), with a mean hazard index of 14.

Groundwater - Industrial Scenario

Antimony, arsenic, heptachlor, and thallium were identified as groundwater pathway COCs. As shown in Figure 10.10-7 and Table 10.10.19, arsenic and heptachlor were primary contributors to risk projections for AOC 709 groundwater. Risk estimates ranged from 7E-05 (FDS16C02) to 3E-03 (FDS16B03), with a mean ILCR of 6E-04. Arsenic and thallium were the primary contributors to hazard estimates, antimony was a secondary contributor. Figure 10.10-8 illustrates point hazard estimates for groundwater for the industrial scenario. Hazard estimates ranged from 0.4 (FDS16C02) to 17 (FDS16B03), with a mean hazard index of 4.

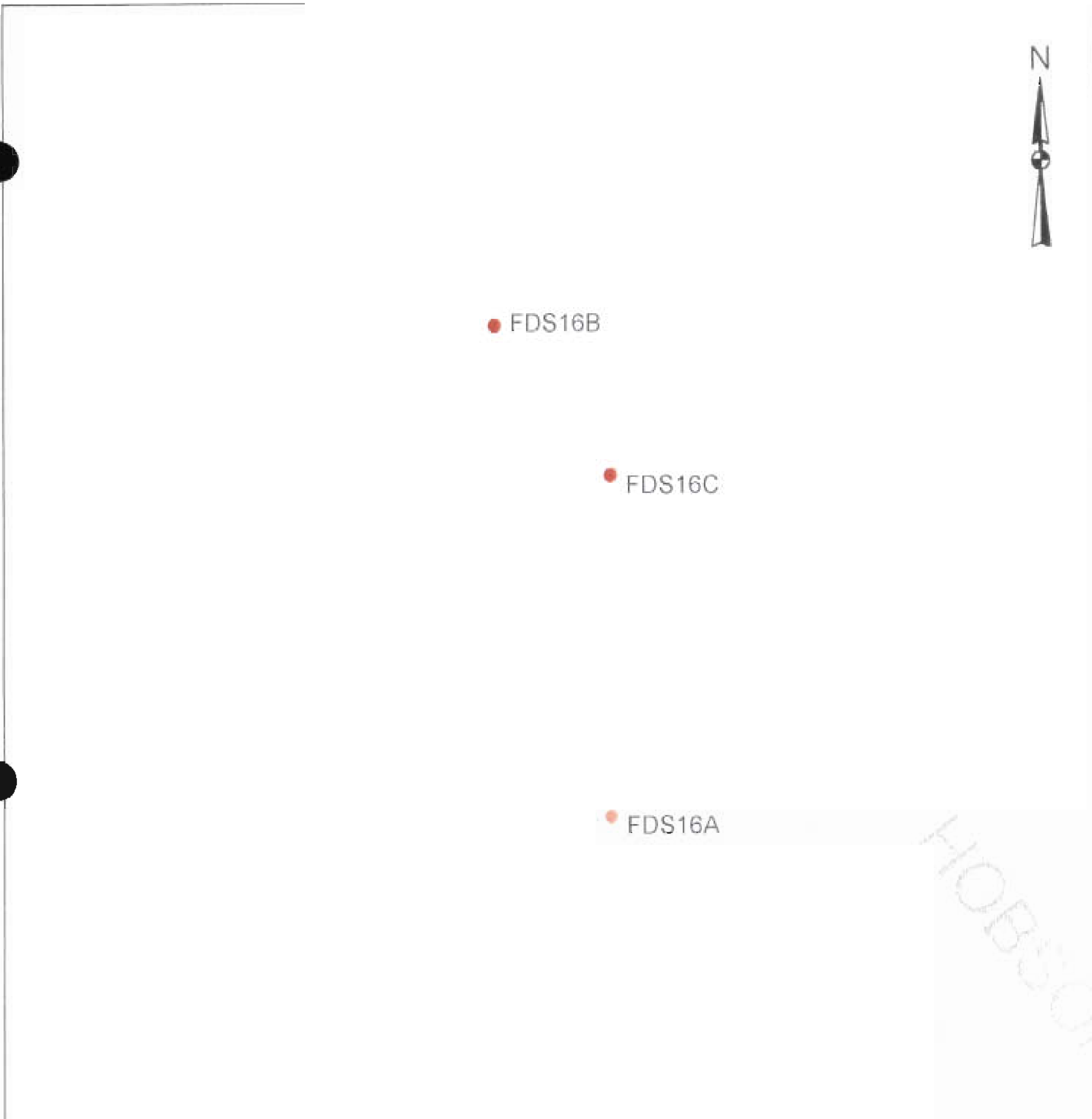
10.10.6.8 Remedial Goal Options

Groundwater

Groundwater RGOs based on the site resident scenario and site worker are shown in Table 10.10.20.

10.10.7 Corrective Measures Considerations

For AOC 709, the lower soil interval and shallow groundwater were investigated. Three groundwater monitoring wells were installed in the shallow aquifer. Based on the analytical results and the human health risk assessment, COCs requiring further evaluation through the CMS process were identified for the shallow groundwater. However, residential use of the site is not expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use. The site is mostly paved with asphalt and concrete.



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE F - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10-6
AOC 709

POINT HAZARD ESTIMATES FOR
GROUNDWATER
RESIDENTIAL SCENARIO

ZONE F - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10-7
AOC 709

POINT RISK ESTIMATES FOR
GROUNDWATER
INDUSTRIAL SCENARIO

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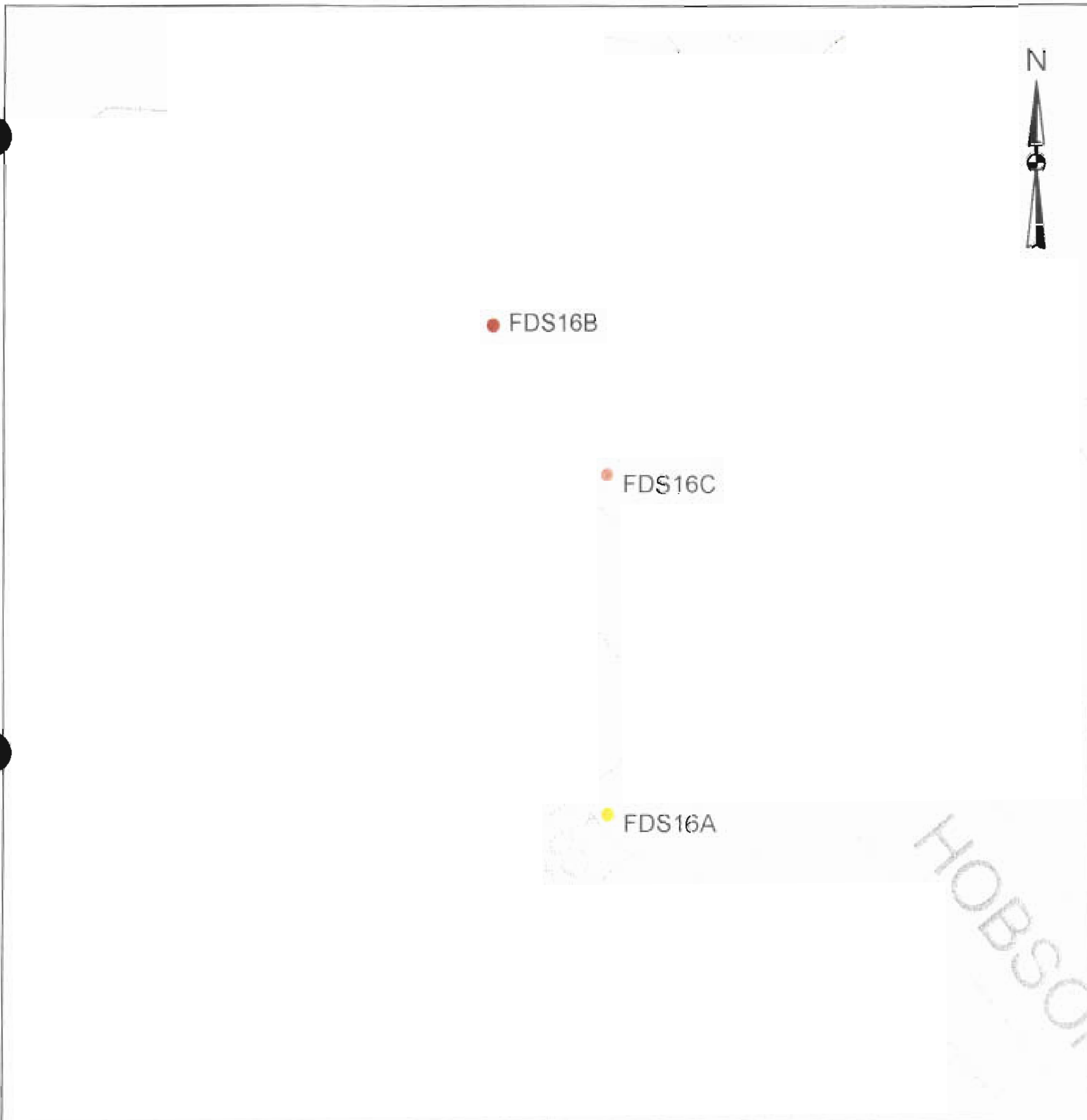
Table 10.10.19
Point Estimates of Risk and Hazard - Groundwater Pathways
Industrial Scenario
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Sample ID	Parameter	Concentration	Units	Hazard Index	Risk (E-06)
FDS16A01	Antimony (Sb)	3.9	UG/L	0.191	NA
FDS16A01	Arsenic (As)	9.9	UG/L	0.646	103.79
FDS16A01	Heptachlor	0.049	UG/L	0.003	2.32
			Total	0.839	106.11
FDS16A02	Arsenic (As)	12.1	UG/L	0.789	126.85
			Total	0.789	126.85
FDS16A03	Arsenic (As)	9.8	UG/L	0.639	102.74
			Total	0.639	102.74
FDS16A04	Arsenic (As)	6.7	UG/L	0.437	70.24
			Total	0.437	70.24
FDS16B01	Antimony (Sb)	4.2	UG/L	0.205	NA
FDS16B01	Arsenic (As)	28.5	UG/L	1.859	298.78
FDS16B01	Thallium (Tl)	6.4	UG/L	1.566	NA
			Total	3.630	298.78
FDS16B02	Arsenic (As)	94.6	UG/L	6.171	991.75
			Total	6.171	991.75
FDS16B03	Arsenic (As)	254	UG/L	16.569	2662.85
			Total	16.569	2662.85
FDS16B04	Arsenic (As)	236	UG/L	15.395	2474.14
			Total	15.395	2474.14
FDS16C01	Antimony (Sb)	3.1	UG/L	0.152	NA
FDS16C01	Arsenic (As)	9.4	UG/L	0.613	98.55
FDS16C01	Thallium (Tl)	4.6	UG/L	1.125	NA
			Total	1.890	98.55
FDS16C02	Arsenic (As)	6.2	UG/L	0.404	65.00
			Total	0.404	65.00
FDS16C03	Arsenic (As)	29.6	UG/L	1.931	310.32
			Total	1.931	310.32
FDS16C04	Arsenic (As)	42.3	UG/L	2.759	443.46
			Total	2.759	443.46



LEGEND

- NO COPCs
- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

40 0 40 80 Feet

ZONE F - RCRA
FACILITY INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, SC

FIGURE 10.10-8
AOC 709

POINT HAZARD ESTIMATES FOR
GROUNDWATER
INDUSTRIAL SCENARIO

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Table 10.10.20
Remedial Goal Options Groundwater
AOC 709
Charleston Naval Complex, Zone F
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	Hazard-Based Remedial Goal Options 1.0 mg/l	Hazard-Based Remedial Goal Options 3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	Risk-Based Remedial Goal Options 1E-05 mg/l	Risk-Based Remedial Goal Options 1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Antimony (Sb)	NA	0.0004	0.0031	0.00063	0.0063	0.019	ND	ND	ND	NA	0.006
Arsenic (As)	1.5	0.0003	0.25	0.00047	0.0047	0.014	0.000044	0.00044	0.0044	0.0167	0.05
Heptachlor	4.5	0.0005	4.9E-05	0.001	0.01	0.02	0.000015	0.00015	0.0015	NA	0.0004
Thallium (Tl)	NA	7E-05	0.0037	0.00011	0.0011	0.0033	ND	ND	ND	0.002	0.002

Worker-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	Hazard-Based Remedial Goal Options 1.0 mg/l	Hazard-Based Remedial Goal Options 3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	Risk-Based Remedial Goal Options 1E-05 mg/l	Risk-Based Remedial Goal Options 1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Antimony (Sb)	NA	0.0004	0.0031	0.0041	0.041	0.12	ND	ND	ND	NA	0.006
Arsenic (As)	1.5	0.0003	0.25	0.0031	0.031	0.092	0.00019	0.0019	0.019	0.0167	0.05
Heptachlor	4.5	0.0005	4.9E-05	0.005	0.05	0.2	0.000064	0.00064	0.0064	NA	0.0004
Thallium (Tl)	NA	7E-05	0.0037	0.00072	0.0072	0.021	ND	ND	ND	0.002	0.002

NOTES:

EPC	Exposure point concentration
NA	Not applicable
ND	Not determined
-	Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Four COCs, antimony, arsenic, heptachlor and thallium, were identified in the shallow groundwater for AOC 709 have a calculated HI of 58 (resident child) associated with the present concentration which is above USEPA's acceptable HI of 1. The hazard-based RGOs, for antimony, arsenic, heptachlor, and thallium are 0.0063 mg/L, 0.0047 mg/L, 0.01 mg/L, and 0.0011 mg/L respectively, based on a target of HI of 1.

Potential corrective measures for the shallow groundwater and respective COCs are provided in Table 10.10.21. Corrective measures for AOC 709 are detailed in Section 9.

Table 10.10.21
Potential Corrective Measures for AOC 709

Medium	Compounds of Concern	Potential Corrective Measures
Shallow Groundwater	Antimony, arsenic, heptachlor and thallium	a) No action b) Intrinsic remediation and monitoring c) In-situ, chemical and physical treatment d) Ex-situ, chemical and physical treatment

SECTION 11

11.0 CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

The RFI in Zone F was conducted to determine which sites, if any, designated as AOCs and/or SWMUs during the RFA pose unacceptable risk to human health or the environment (ecological concerns) and will require additional evaluation under the CMS. The conclusions reached regarding each site are based on a technical evaluation of the data following procedures outlined in the CNC *Comprehensive RFI Work Plan*, regulatory guidance, and as required by the Part B permit. The CNC project team has established a conservative protocol for using risk and hazard based thresholds to make preliminary recommendations for each site. The recommendations will be for no further action, additional evaluation under the CMS, additional sampling needed to complete the RFI (in which case an addendum to the report will be required). The protocol for determining which course of action may be appropriate is as follows:

- NFA - Human health risks do not exceed the 1E-06 residential ILCR and the hazard index is <1. Potential risk to ecological receptors is low based on the criteria described in Section 11.9.

- CMS - One or more of the thresholds listed above for NFA is exceeded.

- Additional Sampling Required - Data gaps exist for one or more media investigated. The data gaps are significant enough to preclude a NFA or CMS recommendation.

The recommendations are to be considered preliminary until the risk managers with the USEPA, SCDHEC, and the Navy have reviewed the data and a final decision is reached. The reason being that the USEPA generally find a residential risk range of 1E-04 to 1E-06 acceptable for human health because of the conservative nature of the baseline risk assessment. SCDHEC recommends a site specific risk decision generally determined by cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and an individual ILCR which exceeds 1E-06 or an individual hazard quotient exceeding 0.1. This means some sites currently recommended for CMS may not require any further action once all the weight of evidence such as frequency of detection/spatial distribution, realistic exposure potential, nature of contaminants driving risk, data trends for quarterly groundwater monitoring events, etc. are considered. No further action recommendations are not acceptable for sites where a potential risk exists under a residential scenario even though an industrial reuse of the property is expected since institutional controls for the site will be required. Final recommendations and the rationale for the risk management decisions will be documented in the final version of this report.

A summary of the preliminary recommendations for all the sites investigated in Zone F is included in Table 11.1.

Table 11.1
Zone F Site Conclusions and Preliminary Recommendations

Site Designation	Conclusion/Recommendations
SWMU 4 and AOC 619	Recommended for CMS - Surface soil and shallow groundwater
SWMU 36 and AOC 620	Recommended for CMS - Surface soil and shallow groundwater
SWMU 109	Recommended for CMS - Surface soil
AOC 607	Recommended for CMS - Shallow Groundwater
AOC 609	Recommended for CMS - Surface soil
AOC 611	Recommended for CMS - Surface soil
AOCs 613/615 and SWMU 175	Recommended for CMS - Surface Soil and Shallow Groundwater
AOC 616	No Further Action
AOC 617	Recommended for CMS - Surface Soil and Shallow Groundwater
AOC 709	Recommended for CMS - Shallow Groundwater

The following sections summarize the recommendations for each site, level of risk/hazard posed by each of the sites recommended for corrective measures, the media affected, and the chemicals driving that risk.

11.1 SWMU 4, Pesticide Storage Building; AOC 619, Former Oil Storage Yard

These sites were combined into one investigation due to their close proximity and their potential for similar COPCs. SWMU 4 (a RFI site) is a building used to store various insecticides and rodenticides since 1980. The building has a formulation and mixing room, and equipment wash area, and sink and floor drains connected to the base sanitary sewer system. Pesticide storage at the facility was discontinued after 1985, and afterward the building was used for miscellaneous storage only. Materials released, stored or disposed of at the facility included various pesticides. AOC 619 (a CSI site) is a former oil storage yard used from 1955 to 1982 to store waste oil, possibly in an open pit. The possibility of an open pit storage area, along with the observation of stressed vegetation in the area were noted as increasing the potential for contamination at this site. Materials released, stored, or disposed of at this site included petroleum products.

This site is recommended for a surface soil CMS based on an ILCR of 3E-06. The shallow groundwater should also be addressed in a CMS based on a HI of 5 and ILCR of 2E-06. Table 11.2 lists the affected media, the risk/hazard, and the chemicals that drove the risk.

Table 11.2
SWMU 4 and AOC 619
Conclusion Summary

Affected Media	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface Soil	Yes - ILCR = 3E-06 No - HI = 0.06	BEQs Manganese
Shallow Groundwater	Yes - ILCR = 2E-06	Chloromethane
	Yes - HI = 5	Thallium

11.2 SWMU 36, Building 68 Battery Shop; AOC 620, Battery Shop, Building 68

These two RFI sites, were combined into one investigation due to their proximity and their potential for similar COPCs. The site area is located in Building 68, a 48,000 square foot concrete structure. From 1942 to 1952, the building was a paint and oil warehouse. From 1952, the building was used for destruction, assembly, and rebuilding of submarine batteries. Most recently, the building was used for storage and charging of large acid batteries. SWMU 36 is the site of two sulfuric acid releases, where acid was discharged to floor drains which had become separated from the floor, allowing the acid to drain to the soil beneath the building. AOC 620 comprises all activities within Building 68 that were related to the battery shop. Materials released, stored or disposed of at the site included sulfuric acid, lead, paint, solvents, petroleum products, and batteries.

These sites have been recommended for surface soil and shallow groundwater CMS due to a risk greater than 1E-06 and a HI >1. Table 11.3 lists the affected media, the risk/hazard, and the chemicals that drive the risk.

Table 11.3
SWMU 36 and AOC 620
Conclusion Summary

Affected Media	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 1E-04 Yes - HI = 2	BEQs, and arsenic, aluminum, arsenic and chromium
Shallow groundwater	Yes - ILCR = ND Yes - HI = 9	 Thallium and barium

11.3 SWMU 109, Abrasive Blast Media Storage Area

SWMU 109 (a CSI site) is the abrasive blast media storage area. The site consists of three hoppers identified as Buildings 1364, 1365, and 1393, used to store the abrasive blast media.

Hoppers 1364 and 1365 began operation in 1949, while hopper 1393 was added in 1962. Particulate air emissions were permitted at the site in 1992. Materials released, stored, or disposed of at the site included aluminum oxide and "black beauty" blast media.

The site is recommended for CMS of surface soil based on an ILCR of 4E-04 and HI of 7. Table 11.4 lists the affected medium, the risk/hazard, and the chemical(s) that drive the risk.

Table 11.4
SWMU 109
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 2E-04	Arsenic, beryllium and BEQs,
	Yes - HI =7.0	

11.4 AOC 607, Dry Cleaning Building 1189

A RFI site, AOC 607 is the former dry-cleaning facility at Building 1189, which operated from 1942 to 1986. From 1986, the facility was used as a laundry, housing two industrial washers and dryers. While operating as a dry-cleaning establishment, the facility was classified as a minor emitter of total hydrocarbons. Materials released, stored, or disposed of at the site included perchlorethylene solvent.

AOC 607 is recommended for a shallow groundwater CMS based on an ILCR of 2E-02 and a HI of 346. Table 11.5 lists the affected medium, the risk/hazard, and the chemicals that drive the risk.

Table 11.5
AOC 607
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard Future Residential Scenario	Chemicals Driving Risk
Surface Soil	No - ILCR = 4E-07 No - HI = 0.1	Vinyl Chloride Aluminum
Shallow Groundwater	Yes - ILCR = 2E-02	Tetrachloroethene, Arsenic, trichloride and vinyl chloride
	Yes - HI = 346	Tetrachloroethene, trichloroethene and arsenic

11.5 AOC 609, Service Station, Building 1346

AOC 609 is the former gasoline station, automotive repair and maintenance shop at Building 1346, which was built in 1962. The focus of the RFI is the waste oil UST at Building 1346. Materials released, stored or disposed of at the site included gasoline, diesel fuel, motor/lubricating oils, degreasing solvents, antifreeze and various automotive products.

AOC 609 soil has been recommended for CMS based on risk greater than 1E-06 in surface soil.

Although the shallow groundwater ILCR and HI greatly exceed the trigger criteria, this risk and hazard is driven primarily by benzene. The source of the benzene is the leaking fuel UST currently being remedial and not the waste oil UST which is the subject of this RFI. Even though arsenic is a contributor to the groundwater ingestion pathway risk, this element was detected in shallow groundwater throughout the zone at similar concentrations Table 11.6 lists the affected medium, the risk/hazard, and the chemical(s) that drive the risk.

Table 11.6
AOC 609
Conclusion Summary

Affected Media	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 3E-04 Yes - HI = 6	Arsenic, Beryllium and BEQs Arsenic, Antimony and Manganese
Shallow Groundwater	Yes - ILCR = 3E-02 Yes - HI = 1353	Benzene and Arsenic Benzene, toluene and 4-methyl phenol

11.6 AOC 611, Grease Rack and Hobby Shop, Former Building 1264

A CSI site, AOC 611 is the site is the former Building 1264, a small garage size structure which was used as an automotive hobby shop from the late 1950s to the early 1960s. The building has since been demolished and the site incorporated into a partially asphalt paved and grass covered area. Materials potentially released, stored, or disposed of at the site include petroleum products, antifreeze, isopropyl alcohol, solvents, degreasers, enamel paint, paint thinner, battery acid, and lead.

AOC 611 surface soil is recommended for CMS based on a ILCR of 5E-04 and a HI of 8. Table 11.7 lists the affected medium, the risk/hazard, and the chemical(s) that drive the risk.

Table 11.7
AOC 611
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 5E-04 Yes - HI = 8	Arsenic, and BEQs Arsenic, mercury and chromium

11.7 AOC 613, Old Locomotive Repair Shop, Former Building 1169; AOC 615, Old Chain Locker, Building 1391 and SWMU 175, Crane Painting Area, Near Building 1277

Though the approved final RFI work plan called for a separate investigation for SWMU 175, these sites were combined into one investigation due to their close proximity and their potential for similar COPCs.

AOC 613 (a RFI site) is located at the former Building 1169, a former locomotive and crane repair facility which operated from the 1930s until 1985, when the building was demolished. Maintenance activities included changing oil, repairing hydraulic systems and equipment overhaul. Materials released, stored, or disposed of at the site included oil, grease, diesel fuel, and cleaning solvents. Numerous spills were reported, some to the storm water drainage system. In addition, a UST at the site alledgedly contained waste oil and other waste liquids. Documentation of an apparent removal of this UST was unavailable. Building 242, built in 1987, occupies a portion of the site area.

AOC 615 (a CSI site) is the site of the former Building 1391, the former chain locker. Operated from 1970 to 1977, the site was used to store and service anchor chain. Materials released, stored, or disposed of at the site included epoxies and resins. These materials were stored in large tanks onsite, used for dipping anchor chain sections. Epoxy and resin wastes were reportedly stored in 55-gallon drums behind the building.

SWMU 175 (a RFI site) is the former crane painting area, situated south and west of Building 1277. The site was used until 1993. The site consists of crane tracks and a paved asphalt road. During previous site visits, visible evidence of former painting activities were noted. Though no spills or releases were documented at this site, a past release was thought probable.

Materials released, stored, or disposed of at the site included blast media, paint constituents, heavy metals, lead, acetone, xylene, and toluene.

A CMS is recommended for soil and shallow groundwater at the combined AOCs 613/615 and SWMU 175 based on an ILCR of 5E-05 and 1E-02 for soil and groundwater respectively. A HI of 5803 for shallow groundwater contributed to this recommendation. Table 11.8 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.8
AOCs 613/615 and SWMU 175
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemical Driving Risk
Surface soil	Yes - ILCR = 5E-05 Yes - HI = 1	Arsenic, Beryllium and BEQs Aluminum and arsenic
Shallow Groundwater	Yes - ILCR = 1E-02 Yes - HI = 5803	Arsenic, benzene, beryllium and bis(2-ethylhexl)phthalate Acenapthene, fluorene, 2-Methylnapthalene and phenanthrene

11.8 AOC 616, Paint Shop, Former Building 1201

A CSI site, AOC 616 is the former Building 1201, which operated as a paint shop from 1955 to 1977. The building has since been demolished and the site incorporated into a parking and storage lot for Building 69. Materials released, stored or disposed of at the site are paint thinner, solvents, and paint supply products.

No COCs were identified at AOC 616, which indicates no threat to current or future human receptors. Therefore, no further action is recommended for this site. Table 11.9 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.9
AOC 611
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemical Driving Risk
Surface soil	NO - ILCR = NA No - HI = 0-0.007	Antimony

11.9 AOC 617, Galvanizing Plant, Former Building 1176

A CSI site, AOC 617 is the former Building 1176, which operated as a galvanizing plant from the early 1940s to approximately 1985. A 3,000 gallon UST apparently was used for onsite chemical storage. The building has since been demolished and Building 69, a shipping and supply center was constructed in the general area. Materials released, stored or disposed of at the site included zinc solutions and inorganic acids.

A CMS for soil and shallow groundwater is recommended for AOC 617 based on ILCRs of 3E-06 and 7E-04 respectively. In addition, metals detected in the groundwater drive a HI of 71. Table 11.10 lists the affected medium, the risk/hazard and the chemicals that drive the risk.

Table 11.10
AOC 617
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Surface soil	Yes - ILCR = 3E-06 No - HI = NA	BEQs
Shallow groundwater	Yes - ILCR = 7E-04 Yes - HI = 71	Arsenic Zinc, thallium, manganese and arsenic

11.10 AOC 709, Former Fuel Distribution System Area 16

This site was included in the investigation of the base-wide Fuel Distribution System (FDS) at Charleston Naval Complex (CNC) as Area 16. During this study, elevated concentrations of inorganic analytes were detected in shallow groundwater above their respective screening criteria. Of primary concern were the concentrations of arsenic detected in well FDS16B. The CNC project team determined RCRA would be the most appropriate program to evaluate this site due to these elevated inorganics.

The source of this problem is unknown. A review of historical maps and aerial photographs identified no obvious source of this contamination. No known past or current activities in the area were distinguished as potential sources. The FDS pipeline associated with this area was used to convey fuel and not waste oil.

A CMS for shallow groundwater is recommended for AOC 709 based on an ILCR of 6E-03 and a HI of 58 (resident child). Table 11.11 lists the affected medium, risk/hazard index and the chemicals that drive the risk.

Table 11.11
AOC 709
Conclusion Summary

Affected Medium	Unacceptable Risk/Hazard in Future Residential Scenario	Chemicals Driving Risk
Shallow groundwater	Yes - ILCR = 6E-03 Yes - HI = 58	Antimony, arsenic, heptachlor, thallium

SECTION 12

12.0 REFERENCES

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SECTION 13

13.0 SIGNATORY REQUIREMENT

Condition I.E. of the HSWA portion of RCRA Part B (permit number: SCO 170 022 560) (SCDHEC, May 4, 1990) states: *All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with 40 CFR §270.11.* The certification reads as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

P. M. Rose
Office In Charge
Caretaker Site Office, Charleston

1/9/98
Date